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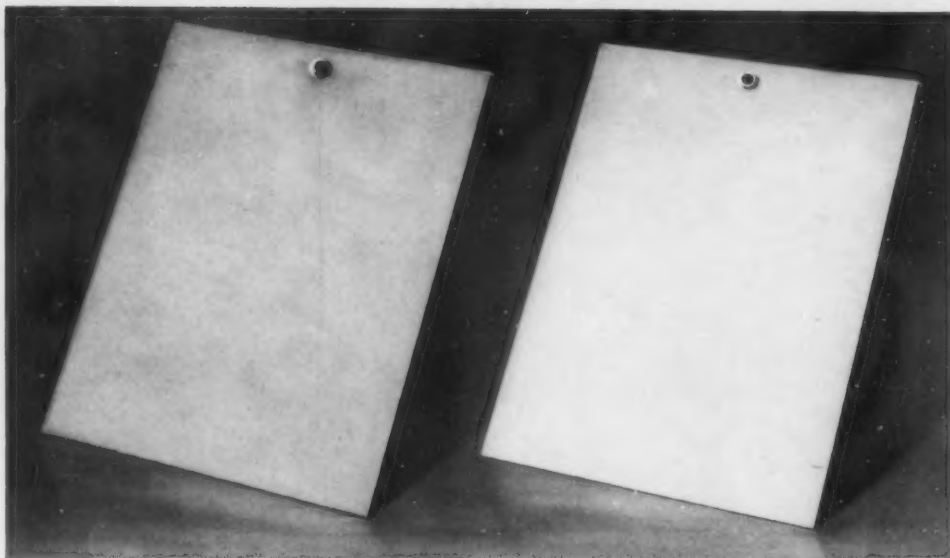
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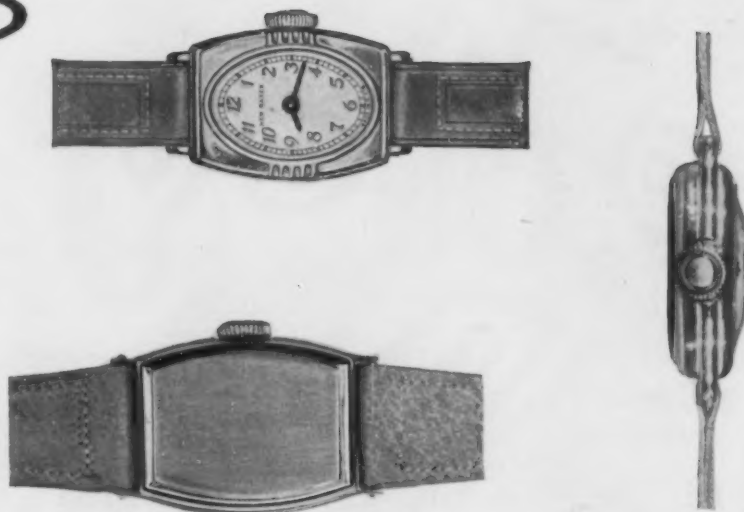
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METAL FINISHING (formerly Metal Industry) has been the leading publication
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Save Plating Chemicals by Solution Control

During the past few months, serious shortages, of certain metals and salts used in electroplating, have arisen. For years American industry has been favored with a bountiful supply of materials used in electroplating, and labor economy was viewed as being far more important than material economy. This was just the opposite of the condition existing in many countries in Europe, where extreme material economy was practiced and is being practiced at the expense of labor economy.

The American electroplating industry, undeniably, has been careless in the use of plating chemicals. Solutions have been discarded without great effort to refine them or restore them to proper working condition. Analytical control of solutions is being done fundamentally to keep the solutions in proper working order rather than to enable most economical use of the materials.

It is time that general use be made of analytical control with the setting of standards of concentrations that are median between maximum operating efficiency and maximum material efficiency. There is little difference, for example, between the operating efficiency of a nickel plating solution containing 30 ounces per gallon of single nickel salts in comparison with a solution containing 40 ounces per gallon, and the drag-out from the solution of higher concentration is proportionately greater.

Likewise, drag-out losses from pickling or acid dipping solutions, alkaline cleaning solutions, cyanide dips, etc., are, in many cases, unduly high due to lack of control or carelessness in adding replenishing chemicals. Many shops make a practice of adding to the cleaning bath, for example, every day or every other day, rather than making additions according to analysis of the cleaner. Cases have been observed where the concentration of cleaners was built up to the saturation point and actual accumulation of solid cleaner in the bottom of

the tank was observed. With the exception of the desire to obtain special properties, such as high conductivity for high speed electrocleaning, properly balanced cleaners should not require concentrations much in excess of 6 ounces per gallon, and as a matter of fact, in many cases detergency is decreased at higher concentrations of the detergent.

The operation of acid dips and pickles is still too empirical and too few shops employ analytical control for pickling solutions. Our country is fortunately blessed with large deposits of sulphur, and pyrite, from which sulfuric acid is made, is readily available, but these supplies are not inexhaustible and future considerations should demand more economical use of acids. Economical use will require the selection of the most efficient concentration, the control of the concentration to prevent excessive drag-out from unduly strong solutions, and the use of inhibitors to obviate unnecessary attack upon the base steel and corresponding waste of acid.

Another approach to increased material economy is the more widespread use of reclaim rinses. This practice is rather extensively used for the expensive metals, such as rhodium, silver, and gold. The use of reclaim rinses for cheaper metals, such as zinc, nickel, chromium and cadmium will result in marked lowering of material costs as well as to contribute to our national economy.

The wasting of metal by unnecessarily high drag-out is just as bad as throwing sheets of metal away that may be of extreme importance to armament. The use of reclaim rinses for the newer high speed concentrated solutions is obviously more important than for the older type of less concentrated solutions.

Design engineers can assist greatly in reducing drag-out losses, particularly for cup-shaped objects, by providing holes and drains in the object, which will allow ready draining of the parts on transfer from one bath to another.

Technical Developments of the Year 1940

By NATHANIEL HALL and G. B. HOGABOOM, JR.

THEORETICAL: One of the most ambitious treatments of the flow of current through an electrolyte, from the mathematical standpoint was presented by Kasper⁷ and included a detailed exposition and discussion of the flow of current through an electrolyte when the electrodes are parallel planes, concentric cylinders and concentric spheres, the whole leading up to a consideration of the current flow in finite systems. Problems involving various electrodes were solved by the author and the effect of polarization on the metal distribution was explained. In the fourth part of this paper, the distance required between anodes and cathodes of various shapes for uniform distribution of current was determined.

These observations have been extended to practice in large scale plating of round wire with zinc. In one case the wire is midway between flat insoluble anodes 4 inches apart. The current distribution is uniform within 1% even if the wire is considerably displaced from the center line. In another article, Beaver² explained the *fundamental principles, forces and particle motion developed in the different shapes of burnishing barrels*. In the case of the long and narrow type of barrel, the author claimed that unless the barrel is loaded almost full, when run at high speed the parts are thrown out of the burnishing mass and the finish is obtained by impinging or impact rather than by pressure. Tinsed finish or semi-pitted appearance, it was claimed, is generally due to too small a quantity of burnishing materials and too great a barrel speed.

Pray and Faust¹ discussed the *chemistry of electropolishing*, its limitations and general considerations from the results of work done at Battelle Memorial Institute. They concluded that high polarization invariably accompanies polishing. Polishing results from selective removal of elevations while the depressions remain passive. The polarization film is thinnest on the elevations and consequently they dissolve with high efficiency.

Petrocelli⁶ determined the *anode and cathode polarization values of copper* in sodium cuprocyanide solutions of various concentrations and Tracy⁴ presented his conclusions, as a result of research in connection with the formulas of the cyanide complexes of copper, zinc and cadmium, that the formulas of the cyanide complexes in the cyanide plating solutions are $\text{Na}_2\text{Cu}(\text{CN})_2$, $\text{Na}_2\text{Zn}(\text{CN})_4$ and $\text{Na}_2\text{Cd}(\text{CN})_4$. In solutions not strongly alkaline such as brass and bronze, the copper nitrate titration was considered to give the most

accurate and consistent results, titrating both the free cyanide and the cyanide combined with the zinc. The silver nitrate titration using potassium iodide indicator was found best with highly alkaline solutions such as cyanide zinc, giving the total cyanide.

Glazunov, Starosta & Vondrasek^{1,2,3} suggested a mechanism for the *deposition of metal on non-conducting surfaces* in close proximity to the region of primary discharge. The mechanism was stated to be due to the primary discharge of a complex cation and this uncharged particle then migrated a short distance before the second decomposition process deposited the metal.

Ryan & Heinrich⁵ studied the *passivity of chromium* and formulated a theory according to which the atoms on the face of each unit cube of chromium share the electrons in their outermost orbits in such a way as to bring about a stable condition. The passivity of the metal was attributed to this complementary relation.

Peirce & Bartells³ investigated the *corrosion of galvanized stock watering tanks* and found a startling correlation between the tin content and corrosion, which they explained on theoretical grounds, to be due to the fact that the tin is present in a tin-zinc alloy as free tin in the grain boundaries, accelerating the corrosion of both the zinc and the iron base.

CORROSION PREVENTION: Hudson⁸ discussed the results of experiments of the Corrosion Committee set up jointly by the Iron and Steel Institute and the British Iron and Steel Federation and recommended a *procedure for surface preparation* which involved thorough descaling of the material prior to application of the first priming coat of paint, either sand or shot blasting or kindred process, or alternatively by pickling. Weathering, followed by hand cleaning was not recommended except in special cases. If pickling is adopted, a finishing dip in dilute phosphoric acid is probably best. The article discussed the failure of paint applied over mill scale. Painting with linseed oil over the hot steel as it came from the mill had been tried for descaling and was not considered satisfactory as a substitute for the recommended methods.

Sand blasting has an advantage over pickling in that it can be carried out in the field, otherwise it was found that there is little to choose between the two processes as regards to results obtained. The committee recommended the duplex pickling process which involves removal of the scale first in dilute sulfuric acid, after which the work is rinsed and dipped for a few minutes

in a hot 2% phosphoric acid solution at 85°C. On removal, the article is allowed to dry without rinsing. Phosphoric acid could be used for the scale removal but is more expensive than sulfuric acid. The work is painted as soon as dry. This process was introduced by Dr. H. B. Footner.

Tests on various paints showed a life on exposure stands of 2.3 years on samples that were not specially primed. When lead chromate was used as a primer this was increased to 3.2 years and with red lead to 3.6 years. The choice of finishing coats was not on the whole so important as the priming coats. Red iron oxide paint seemed to head the list but not in all cases. In cases where maintenance may be inefficient or incomplete, such as might be due to inaccessibility, or if maintenance cost must be kept low, the use of the low alloy steels such as copper bearing, should prove more economical than ordinary steels since the average life of a paint on the former is appreciably greater.

Bablik¹¹ investigated the *zones of iron-zinc alloys* and the effects of temperature of galvanizing and the geometry of the substrate on these zones, also considering the effects of aluminum and tin.

Some phases of hot galvanizing were presented by Imhoff. In one article⁹ he listed among the factors involved in the production of a satisfactory job on *galvanized steel sash*, the use of steel of proper hardness to prevent warping, proper cleaning, pickling, fluxing, galvanizing, drainage and adequate mechanical support. Allowance must be made for the thickness of the coating. In another article¹⁰, the same author discussed the factors affecting the *life of hot dipped zinc coatings* including the effects of weight of coating, purpose or use of coating, kind of base metal, purity of materials, corrosion conditions, adherence of coating, service required, time of exposure, surface conditions, thickness of coating, method of manufacture and ductility of coating. The author pointed out an interesting difference between the ideas of weight and thickness. A thin coating from a bath saturated with iron may weigh more than a thicker coat of pure zinc. To obtain the most satisfactory life from a zinc coating, all the above factors should be considered by the layman when ordering work coated.

Again¹⁵ he discussed the method of *hot tinning gray iron castings* using two or three pots in sequence and zinc ammonium chloride in the amount of 5 lbs. per gallon of water as the flux.

The subject of corrosion prevention of

iron and steel was treated in various patents granted during the year. A *method of rustproofing* consisting of application of a water suspension of an insoluble chromate, then drying, removing the film by brushing and finally lacquering or painting was patented by Thompson & Bristol²¹. This process was also claimed to be effective on zinc. Curtin²² formed a protective film of iron oxides by oxidizing the surface with oxygen at a temperature between 300° and 650°C., and subsequently treating with a dichromate solution.

Mankowich¹³ published results of his tests of the *corrosion of cadmium and zinc deposits* under strictly marine conditions, using 3% sodium chloride solution and continuous immersion for the purpose. The results showed that under these conditions cadmium was superior to zinc. For mild marine exposure they were the same if the unsightly appearance of the zinc did not matter.

Baermann¹⁴ studied plated coatings, particularly copper, brass, nickel and chromium, in relationship to the protection offered zinc base die castings. The effects of running water on these coatings were determined.

Halls¹² tabulated the results of tests on the *durability of various synthetic coatings on zinc base die castings* which were pretreated by chemical and mechanical means, including the different types of chromate and phosphate treatments. The chromate and phosphate finishes gave a much improved bond for subsequent enamel. Chromate finishes gave even better results than phosphates but were more difficult to control. All data were summarized in tables. Tests were made under hot and cold humidity conditions, salt spray and open weather conditions.

The *corrosion prevention of magnesium* and its alloys was the subject of a number of patents. Frisch¹⁶ patented a process comprising anodic oxidation in caustic alkali solution followed by a vitrifying treatment with a solution of a silicate. Fischer and Richter¹⁷ claimed an anodizing process using a solution of caustic soda, soda ash, cyanide and sodium tungstate. Buzzard¹⁸ subjected the anodized film to an immersion in a solution of dichromate and manganese sulfate and various other combinations. In another patent¹⁹, he claimed the use of a solution of dichromate and sulfate for anodizing.

Thompson & Ward²⁰ patented a method of *protecting aluminum from corrosion*, comprising immersion in a solution of hydrofluosilicate and hydrofluosilicic acid plus an accelerating metal salt, after which the surface was subjected to the action of a solution of chromic acid, phosphoric acid, oxalic acid or mixtures of these.

ELECTROPOLISHING: In the paper of Pray & Faust¹ discussed previously, the authors stated that, fundamentally, a solution that would bring about the polarization and solution of the elevations while the recesses remained passive was necessary for electropolishing. More is required however for commercial success. The bath must have good throwing power to handle intricate designs without the use of in-

tricate or unwieldy cathodes and the solution must be simple and applicable to the particular kind of work being polished. The difference between electrolytic and mechanical polishing is that in the former, the surface is leveled by preferential solution of the elevations while, in the latter, the high spots are flowed or removed, the cold working thus changing the nature of the surface, characterized by a "pseudo-amorphous" layer.

In *electropolishing*, deep scratches are not removed. It was emphasized that the process is essentially a "finishing" operation rather than a "roughing" operation, to use mechanical polishing equivalents. Promisel, in a paper on the subject²⁷, and others, suggested that the process be called "electrosmoothing" instead of "electropolishing." Tour²⁴ covered the subject from 1915-1940 with an excellent abstract of the patent and other literature, following which he discussed the *Blaut-Lang process of electropolishing* and the claims and limitations of the other processes. The Blaut-Lang process uses a solution of sulfuric and hydrofluoric acids. Further work has developed a process using phosphoric and sulfuric acids, described further in another article by the same author⁴⁴, the concentrations varying with the type of alloy being treated. An installation consists of a lead lined tank with cooling and heating coils. Copper racks are used and 6-12 volts are required for a current density of 1-5 amperes/sq. in., the process taking 4-10 min. on the average. A special barrel has been developed for bulk work which will take 1,000-2,000 amperes and requires 12-16 volts, it was claimed. The same author treated the Blaut-Lang process briefly in another article²⁵.

Lippert²³ outlined the available information on *electrolytic polishing of stainless steel*, which is very little. An important application is the polishing of refrigerator shelves. A solution of concentrated citric and dilute sulfuric acids is used. The solution is held in a lead lined tank 33' x 5' x 3' and is heated to a comparatively high temperature with electric immersion heaters. Direct current is supplied by a 7,500 ampere/12 volt motor-generator set. The current density for most work is of the order of 0.5-1.5 amperes/sq. in.

Electropolishing is stated to be not a panacea but complementary to mechanical polishing, in the writer's opinion. The final finish obtained electrolytically is definitely related to the condition of the original surface. The process accentuates defects such as pits, scratches, etc. and serves therefore as an inspection method. Thus, frequently the electrochemical treatment can serve as a preparation for mechanical polishing. Starting with a good dense rolled or drawn surface, the electrolytic finish is bright and specular. On rough surfaces such as castings the finish is bright but diffuse. This same process is also discussed by Feild & Clingan²⁶.

Uhlig²⁸ described a process using glycerine and phosphoric acid. The maximum polish on 18-8 was obtained in a solution containing 42% phosphoric acid, 47% glycerine and 11% water, all by weight, at 100°C. or higher with a current density of at least

0.1 amperes/sq. in. Other high boiling materials soluble in phosphoric acid and containing one or more hydroxyl groups also produced practical electrolytes.

Schaefer⁴³ reviewed the literature of anodic polishing of metals for metallographic examination.

MECHANICAL POLISHING: As usual, very little was published during the year on the subject of mechanical polishing. Power²⁹ discussed the causes of high *polishing costs*. Walton³⁰ covered the types and *grades of abrasives*. Tests for uniformity of size with tables and the operations usually employed for finishing various articles were treated in this paper.

Seeley⁴¹ patented a *greaseless buffing compound* comprising a mixture of shellac, rosin, diethylene glycol and abrasive.

Pinner⁴² studied the *effect of base metal polishing* on the character of subsequent nickel plates and concluded tentatively that scratch elimination was not definitely necessary to prevent the formation of a poorly corrosion resistant nickel deposit. A certain amount of fine grain work using a grease lubricant was found to be of major importance.

CLEANING: Hermann & Mitchell³¹ discussed *sand blasting* and tumbling, rolling and burnishing for the purpose of cleaning metals using air sand blasting machines, centrifugal blasting machines, tumbling barrels, etc.

Powney & Wood³² measured the effects of alkalies and surface active agents on the *electrophoretic mobility* of mineral oil dispersions. It was learned that with alkalies, the mobility increases with the pH. With wetting agents there is a critical concentration at which the mobility is a minimum. The variations with temperature, chain length of the wetting agents and the effects of added electrolytes were also investigated.

Bellinger³⁵ discussed various *silicates* and compared them with other alkalies, and suggested them as desirable additions to the ordinary cleaning compounds. Rinker³⁹ discussed various *types of films* encountered in metal cleaning and LoPresti⁴⁰ covered the influence of *hardness in water* on drying and cleaning material costs.

Cleveland³⁶ listed the factors which control the *choice of a cleaner*, the improved type of which will contain three basic elements: (1) an alkali, (2) a surface tension depressant and (3) a high efficiency softening agent. This article gave curves for pH values and conductivities of various alkalies at different concentrations.

Dodd³⁷ patented a material which when added to an alkaline cleaner would *prevent the formation of a stripping film* on metals being cleaned if chromic acid should be transferred to the cleaner by means of racks, etc. Among such materials were furfuraldehyde, dextrose, starch and sucrose.

Darsey & McVey³⁸ received a patent on a *cleaning emulsion* containing a petroleum derivative such as kerosene plus an alkali soap, such as triethanolamine oleate soap and water which was to be followed by a phosphate treatment.

Anderson & Reinhard³³ studied the effect of alkaline cleaning on the adherence of subsequent copper deposits on zinc base die castings. Excellent photomicrographs showed diffusion layers and separation of the deposits from the base metal. The authors concluded that to control blistering, the contact of the zinc base alloy with the alkaline cleaner must be held to a minimum.

West³⁴ recommended reverse current cleaning to prevent the formation of various films, among which were mentioned copper and magnesium compounds, non-adherent non-ferrous metal deposits such as copper, tin, lead, zinc and materials such as decomposed soaps, wetting agents, etc.

BARREL FINISHING: Mann⁴⁵ discussed the mechanism of ball burnishing and gave details as to speeds of rotation, balls, soaps, types of barrels and other data.

Beaver explained the theoretical aspects of burnishing barrel design^{2 46} and the finishing of plastics^{47 48}. In connection with the latter, he pointed out an essential difference between the barrel finishing of metals and of plastics, namely that in the case of the latter the finishing material is 1/3 or 1/4 as heavy as the plastic. Some typical formulas were given for the final waxing or finishing operation, for example 1/2 lb. of beeswax, 1.5 lbs. of carnauba wax and 1 gal. of pure turpentine. Four to six ounces of the wax are used to one bushel of average new pegs, which weigh approximately 24 lbs.

The same author discussed soap and hard water⁴⁹ in connection with their use in barrel finishing of metals. For each grain of hardness per 100 gallons, 2 oz. of the average tallow base soap is required for reduction. Since hardness of water varies and different amounts of soap are therefore required for softening, any general recommendation of a given quantity of soap addition per barrel load would be guesswork. The author recommended the addition of tetrasodium pyrophosphate to eliminate lime soap curds and also a wetting agent for free rinsing.

In other articles, the same author discussed sodium silicate additions to prevent surface attack and etching of soft metals and to enable free rinsing in cold water⁵⁰, barrel liners and barrel designs of various kinds⁵¹, barrel finishing of stainless steel⁵², and unloading and loading of barrels^{53 54}, in the last of which an interesting labor saving device for loading burnishing materials into the barrel was described, involving an air ejector which, at 40-50 lbs./sq. in. pressure returns as much as 1,000 lbs. of burnishing material to the barrel in 10-11 minutes.

A process and compound for polishing plastics in a barrel was patented by Lupo⁵⁵, which consisted of the use of an abrasive material consisting of granular fibrous bases such as wood fragments or sawdust impregnated with a vehicle such as a mixture of wool grease, petrolatum, red oil, mineral cutting oil, etc. and a powdered abrasive bonded thereto. Lupo also was issued a patent⁵⁶ on a tumbling material consisting of material such as vegetable ivory, absorptive fibrous fragments such as sawdust, etc.,

together with an abrasive material and lubricating and adhesive vehicles.

PICKLING: A new Belgian process known as the "deLattre" process was described⁵⁷ for pickling ferrous metals in a mixture of sulfuric and hydrochloric acids at 50°-55°C. Ferrous sulfate is crystallized out when it accumulates to 326-394 g./l. The process has the advantage of hydrochloric acid pickling speed without the losses in acid due to the formation of iron chloride. There are no waste acid disposal problems. The solution contains 1-2 mols of hydrochloric acid and 1 mol of sulfuric acid. A special inhibitor consisting of gelatin peptonized by hydrogen chloride is used.

Loutrel⁵⁸ discussed the use of ferric sulfate plus hydrofluoric acid for pickling stainless steel. The ferric sulfate was claimed to passivate the metal, thus readily controlling attack by acids. It forms ferric fluoride which acts as a reservoir for the small concentration of hydrofluoric acid required to dissolve the scale and it oxidizes the lower oxides in the scale to the higher ones more readily soluble in hydrofluoric acid.

A patent was granted to Dubpernell & Soderburg⁵⁹ on a dip for brightening metals of the cadmium-zinc group, containing chromic acid and a sulfate with a ratio of less than 20:1 or with a chloride ratio of less than 12:1 or with a nitrate ratio of less than 10:1. The chromic acid content may be from 25 g./l. to saturation. The film may be removed with acid. In another patent the film is removed with caustic soda⁶⁰.

A method of removing scale from ferrous metals by contacting them with a fused alloy of lead with at least 0.5% sodium at elevated temperatures was patented by Vincent-Daviss⁶¹.

Wood⁶² patented a method of removing scale from copper base alloys, using a solution of hydrochloric acid, an oxidizing agent to oxidize the copper to the cupric state and, as an activating agent, one of the chlorides of calcium, iron, magnesium and aluminum.

A few acid pickling inhibitors were patented during the year, among them being one consisting of a thiourethane compound such as N-phenyl butyl thiourethane⁶³ and another comprising a substance of the group constituted by the alkylthiocyanates and aralkylthiocyanates, such as methyl thiocyanate, for example⁶⁴.

COATINGS—General: Zapffe & Faust⁶⁵ published the results of experiments in connection with the effect of hydrogen on deposits. They showed that lifting, blistering and possibly poor adherence may be caused by absorbed hydrogen effusing through steel basis metals at ordinary temperatures and the occurrence of these defects is especially favored by heating. Effusion of gas is also a cause of gas pits because it is difficult for metal ions to deposit over small holes through which the gas is continually escaping. Hydrogen adsorption was shown to be severe during cathodic cleaning in either acid or alkaline solutions.

Mathers & Guest⁶⁶ studied the effects of glycerine in plating baths and found that this material increased the throwing power of acid zinc baths within a wide range of current densities and the deposit was improved in quality. On other metals, the effect was not so favorable.

Tests performed by Oplinger⁶⁷ showed that paint and lacquers may be baked on plated die castings successfully at 250°-325°F. without blistering. If heated at 325°F. for two hours or more, diffusion will take place regardless of the precleaning methods.

Deposition from thiosulfate solutions was investigated by Gernes, Lorenz and Montillon⁶⁸. They found that all nickel deposits contained a minimum of 22% sulfur, cadmium deposits also contained sulfur, but only about 5%, and copper and zinc deposits were apparently pure metals. The results led to the recognition of a new type of cathodic reduction which causes the deposition of a compound in metal-like form. Possible mechanisms during deposition were indicated.

Pionetelli⁶⁹ studied the effect of rotation and showed that just as in the case of electrodeposition, rotation of the cathode also resulted in improved immersion or cementation deposits.

COATINGS—Cadmium: Steinberger⁷⁰ described a full automatic plating machine for cadmium plating condensers.

Mathers & Guest studied glycerine foots as a brightening agent for cadmium solutions⁷¹ and found that it gave a much brighter deposit than goulac. They recommended the use of 10-50 g./l. with a current density of 23-42 amperes/sq. ft.

COATINGS—Chromium: Logozzo^{72 75 76} discussed the chromium plating of molds for plastics manufacture. A thickness of 0.001" was deposited, the best solution for the purpose being the 53 oz. chrome solution with a sulfate ratio of 100:1. This was considered preferable to the 33 oz. solution because of better throwing power, slightly brighter finish and heavier concentration which minimized sulfate ratio changes.

The harmful effects of iron in chromium plating solutions were described by Eckardt⁷³ and the addition of 3 g./l. of sodium or ammonium fluoride was recommended to render the iron harmless. The fluoride was effective up to 20 g./l. of iron.

Van der Horst⁷⁴ described a process for plating large pistons and diesel engine cylinders with a porous chromium deposit which holds lubricating oil and can be readily honed. Racking was a real problem since as much as 20,000 amperes might be used on one piece of work.

COATINGS—Copper and Alloys: The effects of annealing and intermittent plating on the structure of heavy nickel and copper deposits were studied by Cuthbertson⁷⁷. In the case of the copper, it was found that the intermittent plating caused semi-discontinuities in the structure, but the practical effect of this was not easy to determine.

Stoddard⁷⁸ developed a method of stripping copper from zinc base die castings in which alternating current was employed in

a solution of 200-500 g./l. of chromic acid with a sulfate ratio of 100:1 at 20°-25°C. and 7-14 amperes/sq. dm. The zinc surface was reactivated after the stripping operation by immersion in a solution containing 10 g./l. of hydrochloric acid at room temperature. Phillips⁷⁹ investigated the effect of moving cathodes on copper deposition from the acid bath and found that the allowable current density is increased with the rate of travel. In a still bath an increase in the temperature resulted in a great increase in the allowable current density.

A patent was issued to Greenspan^{80, 81} on a bright copper solution which contained as a typical formula, 100 g./l. of copper sulfate, 20 g./l. of ammonium sulfate and 80 cc./l. of diethylene triamine, operated at 60°C. and 40 amperes/sq. ft. average. The patent claimed the use of alkyl amines and also an anti-pitting agent.

Two solutions for depositing copper alloys were patented by Sklarew and Cinnamon. One was a solution⁸² containing copper, zinc and tin salts, cyanide, trisodium phosphate, rochelle salt, and sodium carbonate which deposited a gold colored alloy of the above three metals. The other was a cyanide solution⁸³ containing copper, cobalt and tin salts, the first two as cyanides or carbonates and the last as stannate together with various additions for conductivity and brightness, giving a white, corrosion resistant, hard, reflective deposit of copper, cobalt and tin.

COATINGS—Gold: Kushner discussed in detail⁸⁵ the subject of gold plating including the preparation of solutions. An interesting method for completely dissolving a gold anode when preparing a solution electrolytically was described, involving placing a fine mesh stainless steel basket under the anode in contact with the anode bar, on which the gold fragments fall from the anode and from which they dissolve. The author also suggested the use of aluminum instead of the usual zinc and caustic soda in a concentration of 8 oz./gal. instead of 20-30 oz./gal. of sodium or ammonium chloride in the anode compartment of the salt water gold unit⁸⁶.

In another article⁸⁷, he discussed the changes in composition during operation of a gold bath, the structure and color of pure gold deposits and the controlling factors. Slight differences in the color of gold, it was pointed out, are easily distinguishable because gold reflects light in those wave lengths to which the human eye is most sensitive, normally in the yellow range.

Young & Herschlag⁸⁸ investigated the effects of agitation, current density, temperature and pH on the composition of the alloys deposited on a rotating cathode from a cyanide gold solution containing gold, silver, copper and nickel. They found that an increase in agitation increased the gold content, decreased the silver and had no effect on the other metals. An increase in temperature resulted in an increase, then a decrease in the gold, the reverse for the silver, increase in the copper and decrease in the nickel content. Increasing the current density resulted in an increase in the silver and copper, slight decrease in the

gold and no effect on the nickel. An increase in pH caused an increase in the gold and copper, a decrease in the silver and little change in the nickel.

Mason⁸⁹ patented a method of removing gold from copper and alloys and zinc, comprising the use of reverse current in sulfuric acid of specific gravity 1.65 below 100°F., the solution containing when fresh, a small amount of chromic acid or single nickel salts.

Oldam⁹⁰ discussed the source of metallic losses in gold plating, due mainly to drag-out, inadequate equipment and poor operation.

COATINGS—Indium: New data were presented by Fink & Lester⁸⁴ on the effects of various additions to the indium sulfate solution. Boric acid and aluminum sulfate decreased the grain size. Caustic soda gave deposits of poor quality. The best bath consisted of 0.10 M. indium sulfate, 0.30 M. sulfuric acid, 0.0173 M. aluminum sulfate together with 0.0075 g./l. of gelatin, operated at 26°C. with a current density of 0.0325 amperes/sq. cm.

COATINGS—Iron: Richards⁹¹ described the restoration of iron articles by electrodeposition of iron in Germany. The solution used was the ferrous chloride bath. The addition of potassium chloride and boric acid was said to improve the character of the deposits.

COATINGS—Lead: Mathers & Schwartzkopf⁹² studied the deposition of lead from acetate solutions. They recommended a solution containing in grams per liter, 10 of lead acetate, 12-16 of sodium acetate, 2 of acetic acid and 0.4-0.6 of glue with 3-4 drops of cresol dissolved in caustic soda to smoothen the deposit. A current density of 1.2 amperes/sq. dm. may be used and the deposit was claimed to be sufficiently adherent for soldering.

COATINGS—Nickel: Roehl⁹³ published the results of a series of tests to determine the efficacy of various etching methods in the preparation of various base metals prior to nickel plating. The Ollard and a modified Ollard test for adherence were tried. With metals of commercial purity, the adhesive force may approach or exceed the tensile strength of the metal in the case of nickel deposited on clean steel surfaces. For etching nickel-molybdenum steel, the use of reverse current in 25% by weight sulfuric acid at 200 amperes/sq. ft. for 5 minutes at room temperature was effective. For cast materials of the same alloy, treatment at 500 amperes/sq. ft. was required.

Cuthbertson⁷⁷ found that annealing of heavy nickel deposits which had been produced by intermittent plating, resulted in brittleness.

Burdick⁹⁴ patented a strip for nickel and the like coatings from a ferrous base, consisting of concentrated nitric acid and a chlorine compound soluble in the acid, the ratio of nitric acid to chlorine being equivalent to that of 0.03-0.10 grams of sodium chloride in 100 cc. of nitric acid. This strip was claimed to be quantitative and to re-

move 50 mg./sq. in. of nickel in 5 minutes.

Bright nickel occupied the minds of a number of individuals. Maurer⁹⁷ described the cycle and equipment for full automatic bright nickel plating and Spencer⁹⁸ covered the methods of cleaning and plating in the cycle used in what is believed to be the largest bright nickel plating tank in the world, at the Chevrolet Motor Co., division of General Motors Corp. Raub and Wittum⁹⁵ examined about 100 organic compounds for their effect in brightening nickel deposits, obtained from a nickel sulfate, chloride solution. Aliphatic and aromatic compounds were divided into weak and strong brighteners and an attempt was made to correlate organic structure with brightening effects. A translation of this article by Meyer appeared in Metal Finishing⁹⁶.

New brighteners for nickel solutions were patented during the past year. Brown⁹⁹ claimed soluble organic compounds containing the group $-SO_2N=$, such as sulfonamides and sulfonimides in concentrations of from 0.1 g./l. to saturation. Lind, Harshaw and Long¹⁰⁰ claimed an aminopolyaryl methane compound in which at least one amino group is attached to an aryl group and a naphthalene sulfonate. Ballay¹⁰¹ patented the use of 1-20 centigrams per liter of albuminoid material selected from the group consisting of egg and blood albumin stabilized with nickel sulfate solution. Brown also claimed the use of an arsonic acid¹⁰² such as phenylarsonic acid.

COATINGS—Rhodium: The literature on this subject was surveyed by Weisberg¹⁰³ and experimental data on the rhodium sulfate solution were discussed. Curves and tables were given showing the effect of variations in temperature, acidity and current density on cathode efficiency. The minimum free acid content for the sulfate solution was shown to be 3%.

Kushner described methods of rhodium plating¹⁰⁴, especially at the Bart Laboratories where reflectors are plated in what is said to be the largest tank of its kind in the world, holding about 1,300 gallons of rhodium solution. Because of the size, glass or ceramic tanks could not be used and hard rubber lined steel was employed. Chemically pure lead was also used instead of the usual platinum anodes. Approximately 100 dollars worth of rhodium is deposited on a 5 ft. reflector, it was claimed.

COATINGS—Silver: Simon & Lumley¹⁰⁵ studied the deposition of silver at high current densities, using a special apparatus for plating the inside of food can bodies. As an example of the solution, they listed 62 g./l. silver and 60 g./l. free potassium cyanide at 175°F. They found that the current density may be increased by increasing the silver, cyanide, temperature and agitation. Under favorable conditions a current density of at least 200 amperes/sq. ft. was found practical at from 4.5-7.5 volts with a cathode efficiency of 60-70%.

Weder¹⁰⁸ patented a process for producing adherent silver deposits on copper electrical contact points by first depositing a film of mercury electrolytically, using a solution of mercuric chloride, sodium cy-

anide, ammonium chloride and water.

Liebetanz¹⁰⁶ described the disadvantages of carbon disulfide as a brightener in silver plating solutions. Thiocarbamic acid derivatives, which do not develop ammonia, were recommended as brighteners. These included thiosemicarbazide and the monoethyl ammonium salt of the monoethylthiolthioncarbamidic acid.

Weiner¹⁰⁷ obtained bright deposits of silver from solutions containing sodium thiosulfate, sodium bisulfite and sodium sulfate. The bisulfite was added to prevent oxidative decomposition of the silver thiosulfate complexes.

COATINGS—Tin: Bauch investigated the conditions of operation of the sodium stannate bath¹⁰⁹ and learned that bivalent tin causes porous and blistered deposits. When the caustic soda content was held above 1 oz./gal. the anode behaviour was more nearly constant, especially with additions of 2 oz./gal. of sodium acetate. A high initial current density was required to film the anodes and prevent them from dissolving as stannous tin. It was found desirable to lower the current density after film formation to obtain high anode efficiency. Presence of bivalent tin was shown by the low potential. The best procedure was to use a non-conducting tank lining to eliminate galvanic action which caused formation of stannous tin.

Sullivan & Pavlish¹¹⁰ described their patented¹¹¹ solution for producing a *cold immersion tin* deposit on copper and brass, which contains sodium cyanide, stannous chloride and caustic soda in amounts preferably of 50.0 g./l., 5.0 g./l. and 5.6 g./l. respectively. A 30 minute immersion was claimed to deposit 0.00001" of tin. The deposit could also be heated to diffuse the coating into the base metal after which another immersion coating could be applied. The cost of immersion tin on sheets was estimated to be of the order of 10 cents per 100 sq. ft. This process was also described by Higgins¹¹².

Barrett & Wernlund¹¹³ were granted a patent on an *alkaline stannite plating solution* containing as a smoothening agent, a hydrophilic polyvinyl compound such as polyvinyl alcohol.

Vollmer¹¹⁴ patented a *process of detinning* tin plate by immersion in a solution of sodium metanitrobenzoate, etc. and caustic soda, after which the tin was plated out on suitable cathodes. Another process for stripping tinplate was patented by Robinson¹¹⁵, involving immersion in a solution of stannic chloride with sufficient free hydrochloric acid to produce a pH of -0.27.

COATINGS—Zinc: Bray & Morral¹⁰⁹ studied *addition agents* in the electrodeposition of zinc. They found that amines of low number of carbon alkyl radicals showed tendency toward good addition agent properties. The nitrogen content of the amine per liter of solution must be controlled. The length of the organic radical attached to the amine was also found to have a decided influence.

A patent was issued to Hubbell & Weisberg¹¹⁹ covering an *electroplating solution*

containing zinc and an excess of ammonia over that required to form the zinc tetramine compound, using high current densities such as 500-1,000 amperes/sq. ft. The solution was prepared by leaching ore or sal skimmings from hot galvanizing plants.

Lyons¹¹⁷ claimed that electrogalvanized coatings on wire were more uniform than hot dipped coatings and longer life was to be expected of the former.

Smith¹¹⁶ in a discussion of the operating conditions and control of bright cyanide zinc solutions considered the nitric acid bright dip to be better than the peroxide and sulfuric acid or the chromic acid and sodium sulfate dips.

Among the patents were one to Hull¹¹⁸ for a *brightener* for cyanide zinc solutions consisting of an oxyheterocyclic compound from the group of piperonal, etc. plus a protective colloid such as gelatine, gum arabic, etc., and another to Westbrook¹²⁰ for a brightener consisting of a compound containing a methylenedioxyphenyl group, also with the addition of a metal from the iron group.

Hull^{121,145} described the effect of magnesium and calcium as control agents for *zinc anodes*. The addition of 0.18% magnesium, for example, to the zinc anode, reduced the anode efficiency from 100% to about 84%, the result being that the anode and cathode efficiencies of the cyanide zinc solution become approximately equal and the metal content is kept from rising. The author also received a patent¹²² on the addition of calcium to the anode.

PLATING NON-CONDUCTORS: Re¹²⁴ described a method of plating on baby shoes, including some unorthodox procedures for cleaning, metallizing and plating.

Schore¹²⁵ outlined the preparation of electrolytic deposits on non-metals, including acid-proofing of the base, bronze coating for conductivity, striking in a silver solution for improving conductivity and the like. Examples of procedures for busts, plaques, plaster casts, baby shoes, flowers, etc. were given.

Bayard¹²⁶ discussed the various methods of making plastics electrically conductive, among them being metal spraying, cathode sputtering, metal evaporation and chemical reduction of silver¹²⁶.

Walker was granted a patent¹²⁸ on the use of an *immersion treatment of a plastic surface* in a solution of stannous chloride before metallizing by the silver reduction method, in order to improve the adherence.

The improvement in the conductivity of the bronze powder film often used for metallizing was claimed in a patent granted to Ruben¹²⁷, involving exposure of the coating to a reducing acid vapor, namely hydrochloric acid vapor.

METAL COLORING: There were very few developments in this large field and these were mainly in connection with the black coatings on iron alloys for which a number of patents were granted. Walen & Wilbur¹³⁰ blackened ferrous alloys using the caustic soda-nitrate mixture in two stages with a lower temperature in the first solu-

tion. Zapf¹³² went them one better, using three stages in his patent claims, with progressively higher temperatures. He also claimed the addition of phosphates, iodates and iodides to the caustic soda-nitrate baths. Malcolm¹³¹ received a patent on a process using a water solution of caustic soda, sulfur and phosphoric acid, which was claimed to coat the steel black with a corrosion resistant coating.

Kushner¹²⁹ discussed the *theory of light reflection*, refraction and absorption and the coloring of metals, in a series of articles. He gave a formula for coloring silver light green by the use of reverse current in a solution of: potassium perchlorate, 5 grams; potassium iodide, 30 grams; iodine, 2 grams; ammonia, 40 cc.; and water, 1 liter, at 7 volts. The film produced was a form of silver iodide. A blacker color on zinc than that produced by black nickel was claimed by immersion in a solution of 2 oz. of ammonium molybdate, 4 oz. of ammonium chloride, 1 oz. of boric acid, 1 oz. of potassium nitrate and 1 gallon of water at 180°F. for a few seconds.

Crocker, Crosby and Clappier were granted a patent¹³³ on a process of producing *colored oxide coatings on nickel* and nickel alloys by exposing to a heated oxidizing atmosphere.

Brill¹³⁴ patented a method for *coloring zinc black*, consisting of first treating with a solution of a heavy metal sulfate to deposit an immersion film, followed by immersion in a buffered molybdate solution at about pH 5.

TESTING AND CONTROL: Hardness testing was treated by various authors. Milligan¹³⁷ discussed devices for grading bonded abrasives, which were fundamentally Rockwell hardness testers. Hemingway¹³⁵ described his method for grading bonded abrasives using an ordinary Rockwell tester. The results have been used for the selection of proper stones for superfinishing but the method, it was claimed, could easily be adapted to other operations when bonded wheels are used. Harris¹³⁶ also described a grader called the "Gillette Abrasive Stone" comparator which was developed at the Gillette Safety Razor Co.

Peters & Knoop¹⁴³ measured the hardness of metals in thin layers by indentation with a pyramidal diamond crystal. For a chromium plate, 0.001" thick, they showed that the results were not affected by variations in the hardness of the base metal.

Mahla¹⁵⁰ determined that there was no direct relationship between stresses in copper deposits and hardness, after studying the relative internal stresses using x-ray patterns. In deposits made at low temperature, temperature was shown to be a greater factor than current density in determining the stress, while at high temperatures, current density was the principal factor.

A cathode ray oscillograph was used as an indicating instrument to measure the polarization of electrodes by Hickling¹³⁹, thus eliminating the usual difficulties of reproducibility of electrodes, minute currents, presence of depolarizers, indirect recording of current and extensive apparatus

—all of which are experienced with the mechanical oscillograph.

Brenner¹⁴⁴ studied the concentration gradients of the *cathode film* by freezing the film after a steady state of deposition had been reached. Layers were then machined off for analysis. The tests showed that agitation reduced the thickness of the cathode film and lessened the metal concentration. Increased temperature showed very little change.

Graham & Read¹⁴⁹ developed a new method for sampling the film of electrolyte immediately adjacent to a plating electrode, consisting of drilling a small hole through the electrode and slowly siphoning through this hole while the plating operation was in progress. Variations in acid concentration were found to affect the cathode film more than changes in copper concentrations, when using an acid copper bath.

Springer¹⁴⁸ examined critically the methods for measurement of metallic brightness, particularly that of plated coatings. A photometric method was described which was based on the measurement of diffusely reflected light from an incident angle of 45°. Shirley¹⁴⁰ described an ultra-violet examining apparatus for detection of flaws on surfaces, and Gebert¹⁴¹ discussed the testing of deposits for porosity, describing a modified ferroxyl solution to be sprayed on the article. The solution consisted of 15 grams agar, 6 grams potassium ferricyanide, 60 grams of sodium chloride, 1 liter of water and 250 cc. of ethanol. It was contained in a jar placed in a water bath and kept at 120°F., and was sprayed with compressed oxygen rather than compressed air because the latter may contain some iron dust. The number of blue spots visible in two minutes were used as a measure of the porosity. This test was claimed to be quicker than the salt spray and non-destructive to the article being tested.

Devices for testing the surface tension of solutions were discussed by Hall¹³⁸ and by Hartshorn¹⁵⁴. The former described a simple capillary rise surface tension apparatus which was constructed, using a broken thermometer stem, and reproduced nomographs which eliminated the calculations usually required for the conversion of experimental data to dynes per cm., both for the stalagmometer and for the capillary tube.

Buser¹⁴² patented a method of determining the weight of coating on tin plate in which the tin was stripped anodically in an electrolyte containing hydrochloric acid, potassium iodide and an iodine liberating agent of the group of oxidizing agents, and the liberated iodine was titrated with thiosulfate.

Anderson & Manuel¹⁴⁷ developed an electrolytic chromium plate thickness tester based on the principle that the ampere seconds required to anodically dissolve a given small area of chromium plate are directly proportional to the thickness. The moment the area has been stripped, the potential of the metal changes sharply. A solution of normal trisodium phosphate and normal sodium sulfate was recommended as the electrolyte.

Blum & Olson recommended¹⁴⁶ that for the chromium thickness spot test, hydro-

chloric acid of specific gravity 1.180 ± 0.002 at 60°/60° should be used instead of concentrated C.P. hydrochloric acid since the latter varies in strength and results have consequently not been consistent. The recommended strength corresponds to a normality of 11.5 ± 0.2 N. which may be checked by titration.

Brenner¹⁵¹ compared various reagents for the dropping tests for zinc and cadmium thickness determination and suggested a solution of 200 g./l. of chromic acid and 27 g./l. of sulfuric acid. At 70°F. each second is equal to 0.0000098" of zinc and 0.0000133" of cadmium.

McNabb & Heiman¹⁵² studied the free cyanide analysis in brass plating solutions. The Pan method which assumes free cyanide to be all the cyanide in excess of $\text{NaCu}(\text{CN})_2$ and $\text{NaZn}(\text{CN})_2$ is reproducible it was found, if the carbonates, ammonia, temperature, pH, etc. are carefully controlled. The authors suggested that a brass solution is a mixture of $\text{NaCu}(\text{CN})_2$, $\text{Na}_2\text{Cu}(\text{CN})_4$, $\text{Na}_2\text{Zn}(\text{CN})_4$ and Na_2ZnO_2 , and possibly other complexes such as the zinc ammine.

Gillies & McNabb¹⁵³ proposed a method of determining silver in silver cyanide solutions after removing the cyanide with sulfuric and nitric acids, by titrating with standard potassium iodide using ceric ammonium sulfate and starch as indicators. The results were said to compare favorably with the Volhard method using standard thiocyanate.

FINISHING ECONOMICS: Bregman¹⁵⁵ discussed the determination of costs of barrel and still tank plating, using various tables of operating costs for a variety of plating shops and a breakdown of expenditures per dollar of sales. He concluded that prices for electroplating work should be 2.5 times the total direct labor. The factor can be used for all still plated decorative work. In barrel plating very little labor is required but a long dwell in the tank. Heavy nickel deposits require inclusion of the cost of the metal. Breaking down the costs of barrel plating the cost was found to be 2.08 cents per lb. using a 100 lb. capacity barrel, and including the operations of burnishing before and after plating and a sawdust tumble for bright nickel finish. For white nickel and cadmium plating, the cost would be about 1.04 cents per lb. because only half the man hours are required.

In another article¹⁵⁶, the same author gave comparisons between the bids of different job shop platers for finishing various plumbing fixtures. On one item, a fountain head or bubbler, bids varied from 20 cents to \$1.75 each for refinishing by nickel and chromium plating. In a third article¹⁵⁷, he showed the wide difference between a job plating price set by hard purchasing practice and by a practical time study. A plater who had been receiving 9 cents per piece for a job found he could not do it for less than 12 cents figuring both by the methods involving multiplying the total direct labor by 2.5 and the polishing cost by 3.

Power²⁹ claimed that high polishing costs were due, not so much to incorrect methods of performing the actual operations as to

the selection of the wrong polishing materials and to unsatisfactory practice in the setting-up of the wheels and recommendations were given for most efficient operation.

Beckwith¹⁵⁸ discussed the sources of losses in the plating room especially those due to inefficient use of labor. The author gave an interesting example of an intermittent spray rinse after nickel plating on a full automatic machine. The rinse was controlled by a solenoid valve and was fed back into the plating solution to make up evaporation losses. The drag out cost dropped from 12 dollars to 50 cents per day.

Lyons¹¹⁷ estimated the hourly cost of applying 0.45 oz./sq. ft. of electrozinc on 12 gauge wire to be \$17.01 and the cost per ton to be \$7.09.

MISCELLANEOUS: Haynes¹⁵⁰ presented a new graphical method for estimating the wattage and number of lamps required for particular applications in his discussion of the use of incandescent lamps as a source of radiant heat. Test procedures were outlined and the results and limitations of the process were discussed.

Sumner¹⁶⁰ described an experimental procedure for the anodic deposition of oleoresinous lacquers which are used for ordinary food can linings. An emulsion of the lacquer in sodium aluminate solution was employed. The paper discussed the mechanisms of the deposition and the structure of the deposit. The deposit was produced by coagulation of negatively charged lacquer particles at the anode. The process was particularly adapted to lacquering after fabrication.

Dyktor¹⁶¹ discussed the health hazards common to the electroplating industry and gave methods for their elimination, mainly by adequate ventilation. Russell¹⁶² also presented the subject, listing symptoms and effects of exposure to various materials used in metal finishing. Methods of control were described.

Walter¹⁶³ determined the characteristics of oxide coatings on aluminum produced in the sulfuric acid solution with various concentrations of the acid. These tests included hardness, dielectric properties, dyeing properties and corrosion resistance. The nature of the oxide films produced anodically on aluminum alloys were also described by Roehrig¹⁶⁴.

Fadgen¹⁶⁵ outlined the waste disposal procedures at the Trenton Division of the Ternstedt Mfg. Corp. Cyanide solutions are treated with sulfuric acid until pH 4 is reached and the evolved hydrocyanic acid gas is diluted with sufficient air before discharge through the stack so that a toxic condition is not present. The sulfuric acid addition is automatically stopped if the compressors which supply air for dilution of the hydrocyanic acid gas are stopped. All treatments and tests are conducted from outside the treatment room.

Wernlund & Sunick¹⁶⁶ were granted a patent on a method of cyanide waste disposal in which the cyanide content is reduced below 4 ppm by treating under alkaline conditions with materials such as sulfur and slaked lime.

Lamme¹⁰⁷ patented a method of removing plating salts from crevices of plated articles by subjecting to a chlorinated solvent such as trichlorethylene.

Ewing & Jernstedt¹⁰⁸ studied the cathodic treatment of copper in beryllium sulfate solutions to prevent tarnishing. They found that the addition of 3-5 grams of boric acid per liter to a solution of 3-4 g./l. of beryllium sulfate nearly neutralized with ammonia, aids in forming a transparent and colorless film. The film prevents oxidation in air at elevated temperatures and tarnishing due to sulfur fumes. The recommended conditions for deposition were 50-100 ma./sq. ft. for 4-6 minutes at pH 5.5-5.9 using 7% tin-93% lead anodes. The film is dried thoroughly and heated a few minutes at 275-300°C.

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(Concluded on page 10)

HOT-DIP GALVANIZING IN 1940

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GENERAL STATEMENT:

It cannot be said that galvanizing progress and achievement moves forward only when new equipment appears during the year. This kind of progress is more spectacular sometimes, but it may not be near as important, or as vital to the industry as a whole, as the final solution of some technical problem that has been a "thorn in the flesh" to galvanizers for many years. This seems to be the status of the progress and achievements in hot-dip galvanizing engineering for the year 1940.

THE STEEL BASE IN GALVANIZING:

For many years it has been known by most all galvanizers that the kind of base metal upon which a zinc coating is to be placed, markedly affects the qualities of the zinc coating itself, its life, and the service of the product. The simplest example, is to state that a galvanized coating on wrought iron as a base metal, is much heavier than a galvanized coating on a steel base. A review of the activities in the galvanizing industry is not the place to discuss this illustration. This short introduction has been given to call attention to the most outstanding piece of research work in the field of hot-dip galvanizing engineering for the year 1940. This work was done by Robert W. Sandelin, Metallurgist of the Atlantic Steel Co., Atlanta, Ga. In recognition of the results obtained Mr. Sandelin was awarded the Wire Association Medal for the best paper of 1940. The title of his paper is "Galvanizing Characteristics of Different Types of Steel". The paper was presented in Cleveland, Ohio, October 23, 1940, at the meeting of the Wire Association, and the findings have been made available starting in the November 1940 number of *Wire and Wire Products*, the magazine of the wire industry.

WHITE RUST:

"White Rust" has been a chronic trouble that has confronted the hot-dip galvanizing industry for many years. It has been in the same status that red rust has been in the iron and steel industry, only though of course not nearly so prominent, or aggravating. As a general thing "white rust" is not found on such articles as galvanized metalware; it general appears on a

shipment of pipe that has been transported by boat, or perhaps on sheets in a warehouse, or on some kind of a galvanized product that has to be stored in bins, such as zinc-coated pole-line hardware, or small galvanized nails, and similar articles.

"White rust" is a white powder that covers the surface, and while it may not materially harm the article, its presence does ruin its appearance. So for many years on certain kinds of galvanized products such steps as dipping in oil, or some product to stop corrosion, has been practiced. These have not been wholly satisfactory for a number of reasons. So the finding of a suitable material in 1940 in the form of a clear, transparent lacquer*, the same as used for toys, is indeed a valuable achievement of progress. The writer I believe discovered this product for the galvanizing industry, if such a term can be used for taking a product on the open market which has been made for one field, and experimenting and testing, to find it extremely valuable and useful in another. The writer has been hunting for such a material for twelve years, and the research work done on this new lacquer at last rewarded the efforts made, in that this product is applied cold, by hand dipping in tanks, or it can be sprayed, it dries quickly in the air, it is water clear and transparent, it is thin, and it seems to fill all the requirements of "wrapping galvanized products in cellophane", just like toys, candy, and cigars.

TIN IN ZINC COATINGS:

Another phase of hot-dip galvanizing that has been a factor of much technical interest for many years is the effect of the metal tin in zinc coatings. G. C. Bartells presented a paper at the Twenty-second Annual Meeting of the American Zinc Institute in St. Louis, Mo., April 29-30, 1940, the title of which was—"Tank Tests—Progress Report". The point of interest and much value was that service specimen water tanks that gave a life as long as up to 46 years, all had less than 0.4% of tin in the zinc coating, and in new tanks, the longest life was 6 years, and the tin content of the coatings varied up to 1.50%.

* Name furnished by METAL FINISHING on request.

The vital practical interest shown in the past year in this phase of galvanizing has been demonstrated by the fact that discussions on the amount of tin in zinc coatings have come up many times. Attention has been called to the fact that a galvanized bucket is never thrown away because of coating failure, and this type of coating may carry not only 1.50% of tin, but also other metals such as cadmium, aluminum, and antimony. Still further complications arise from the fact that the same kind of tank failures have been observed on large tanks without any zinc coating on them at all, and the failure has been traced to scale rolled down in the steel when the plates were rolled. Yet the facts do seem to bear out the findings of Mr. Bartells, namely that over 0.4% of tin in zinc coatings is harmful.

REPAIR OF GALVANIZED COATINGS:

While the repair of galvanized coatings has always been of live and vital interest, the National Defense Program has made it much more important to be able to repair a product which otherwise might have to be regalvanized, or perhaps scrapped entirely. The past year therefore has seen a very active interest in a new product* placed on the market, in the form of what has been called a galvanizing powder.

RUST-PROOFING TREATMENTS TEMPORARY AND PERMANENT:

The galvanizing industry during 1940 has become more conscious of temporary rust-proofing methods, and permanent rust-proofing coatings, such as offered by hot-dip galvanizing. For many years the automobile companies were troubled with rust-spots coming out through the body paint. It was not until temporary rust-proofing methods were adopted in 1935 that these pin-holes disappeared. Unfortunately, unintentionally, considerable confusion developed in the hot-dip galvanizing industry itself, and also in its trade and markets, in regard to the values of these temporary rust-proofing processes, as compared to the permanent rust-proofing process of hot-dip galvanizing, a very large part of the zinc coatings never being painted at all.

The same confusion is still prevalent in

regard to the value of electroplated coatings as compared to hot-dip galvanized coatings. The outside hardware of a new home was electroplated, and used by mistake, completely ruining the white paint due to heavy rust streaks on it after the hardware had been in service less than three months. The past year therefore has been one of vital interest in finding a satisfactory means of distinguishing between *temporary rust-proofing methods*, and *permanent rust-proofing methods*, such as hot-dip galvanizing. A red ball has been suggested for all outside service, and a green ball for all inside service. Such notation is similar to painting of steel ends different colors, a method which has proven satisfactory in the steel industry for a number of years.

DOUBLE BOILER FOR MELTING ZINC:

In the field of new equipment, an item appeared in *The Iron Age* of May 30, 1940, by the above title, which described a pot for holding molten zinc at the Glenn L. Martin Co., Baltimore, Md. While this method of using two steel pots, the inside one filled with zinc, and surrounded by molten lead in another steel pot outside of the inside pot, was used for holding zinc for drop hammer dies, still the equipment was of much interest to hot-dip galvanizers. The idea while patented, did not appear new in galvanizing as a sheet galvanizing plant had been using the principle of two pots for many years. The writer had also suggested that the same method in 1924 be used for heating galvanizing pots, but nothing was ever done about it. Meanwhile careful study still continues in the combustion engineering of hot-dip galvanizing furnaces.

HYDROFLUORIC ACID PICKLING EQUIPMENT:

Another new development during the past year has been the appearance of graphite pipe and heating coils* to be used for hydrofluoric and nitric acid pickling. Carbon brick and tile are also available for the linings of pickling tanks to be used for hydrofluoric acid pickling.

* Name furnished by METAL FINISHING on request.

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Review of Developments of 1940 in Electroplating Equipment and Supplies

BY DR. WALTER R. MEYER

Editor

The following review of new processes, materials, supplies and equipment made available to the industry in 1940, has been correlated from announcements appearing in the 1940 issues of *Metal Finishing*. The New Equipment section of *Metal Finishing* is available to any manufacturer to announce, free of charge, a new product of interest to the plating and finishing industries.

Names of manufacturers or suppliers of equipment, materials or processes mentioned, will be gladly furnished to anyone upon request.

The rearmament program resulted in marked increase in business on plating equipment and supplies, particularly for automatic equipment because of the desire for high speed production finishing. Most of the chemicals used in plating processes were available, but in certain cases, a marked shortage exists. For example, the shortage of zinc anodes to be used in zinc plating, has almost approached a crisis. Promises for delivery are only being made on a limited scale for short periods of time.

The shortage in potassium cyanide has been overcome by the manufacturer of this chemical by two companies in the United States. Thiourea, used to a limited extent in plating and which was formerly obtained from Germany, is now being made by an American chemical company.

New Plating and Finishing Processes

Plating on Non-Conductive Materials: There has been considerable interest in plating on non-conductive surfaces such as wood, plastics, leather, etc. There has been a marked increase in the business of plating baby shoes and the finishing of plastics for costume jewelry. The plated plastic jewelry is considerably lighter in weight than all-metal jewelry with almost all types of finishes available, such as gold, silver, oxidized finishes and chromium.

Two processes have been announced for plating upon plastics. One is called "Metalon Encasing Process", which is said to permit the plating upon smooth plastic surfaces, thus obviating the necessity of previous roughening of the plastic by mechanical or chemical means. Patents have been granted during the year on the "Metalplast" process which involves treatment of the plastic with a stannous chloride solution followed by silver reduction and deposition upon the surface of the plastic. The silver deposits produced can then be plated further with other metals.

Colloidal graphite materials have been announced for impregnating or saturating fabrics and paper to render them electrically conductive. The materials are said to contain colloidal graphite, small amounts of hardenable organic colloid and a hardening agent.

Black Oxidizing of Steel: Improvements have been made in various treating processes that produce black magnetic oxide coatings upon iron. These black coatings are applied to steel to lessen reflectance, such as for armament parts, to reduce friction and to give corrosion protection where change in dimension cannot be tolerated. Their corrosion protective value is usually further enhanced by coating with rust proofing oils. Two-bath finishing systems have been announced during the year; one system for example, employs treatment in a bath operated from 280-290° F., followed by a treatment in the second bath operated from 305° to 315° F. Single tank treating processes are also available.

Plating Upon Aluminum: A process has been developed for plating zinc and cadmium directly upon aluminum without an intermediate coat of nickel. It is thus possible to zinc plate aluminum and then immersion blacken the zinc to produce an adherent black coating upon aluminum. The cadmium plated aluminum coatings are particularly advantageous for soldering, as aluminum is very difficult to solder directly. Another development has been the brass plating upon aluminum without an intermediate coating. The chief purpose of brass plating is to provide a suitable bond for adherence between the metal and rubber.

A new process for plating upon aluminum was announced. This process involves the use of a two to four minute dip in a solution known as "Pre-Plate", which is operated at room temperature and requires no electrolytic treatment. After this dip, the work is claimed to be suitable for plating in regular alkaline plating solutions, such as gold, silver, copper and cadmium. For depositing metals from acid baths, such as nickel or chromium, the work must be first copper plated after using the "Pre-Plate" process.

Brass Plating: A high speed brass plating process has been marketed which is stated to operate at high current efficiencies and to maintain uniform color for wide ranges of current density. This last named property is particularly important for maintaining a uniform color on irregularly shaped objects. Cathode efficiencies from 50 to 80%

and current densities up to 25 amperes per sq. ft., are claimed.

Copper Plating: A new copper plating process involving the use of complex amine salts of copper plus an addition of ammonium salts, has been patented. The solution is said to be suitable for operation over wide ranges of temperature and current densities, the recommended temperature range being 120 to 140° F., and the current density 40 to 50 amperes per sq. ft. The deposits are said to be light in color, uniformly bright and with cathode efficiencies approaching 100%.

Stripping of copper from zinc base die castings is reported to be done without attacking the base zinc by alternate rapid immersions in a polysulphide solution and a sodium cyanide solution with proper rinses in between.

Gold Plating Solutions: Standardized 24 K gold plating solutions were announced which are reported to operate with high efficiency and to give uniformity of color with good throwing power. Special reagents are available for preparing electroplating solutions to produce pink, red and green gold deposits.

Nickel: There has been a steady increase in the use of bright nickel plating processes, replacing the old dull plating solutions. A new addition agent for producing brilliant, lustrous, adherent deposits has been marketed. The material is used in a quantity of 1 gallon to each 100 gallons of cold nickel solution.

The stripping of nickel deposits from base metals has always been troublesome because of attack on the base metal. An interesting development has been an addition agent which, when added to the sulphuric acid strip, is stated to reduce attack on the base metal and thus prevent pitting and roughening of the surface. The material is used in quantity of ¼ to ½ oz. per gallon, and the maintenance of voltages from 6 to 12 is required.

Silver Plating: There has been little improvement during the year in silver plating solutions. The potassium cyanide made in this country appears to be purer and more uniform than the potassium cyanide obtained from foreign sources. The literature has reported solutions for depositing silver from thiosulphate baths, but the common commercial bath is still the potassium cyanide complex solution with carbon disulphide as the standard brightener although there has been some interest in the use of substituted thiocarbamates.

Portable equipment for the **brush plating of silver** has been marketed. The kit is powered by either a transformer-rectifier or by dry batteries and is recommended for plating over worn spots, for the finishing of limited areas of metal, and for the re-finishing of parts in situ.

Tin-Lead Alloy Plating: A bath for the deposition of tin-lead alloys has been an-

nounced. The deposits are stated to be ideal for soldering. The solution is operated at room temperature with current densities up to 50 amperes per sq. ft., with high cathode efficiency.

Cleaning

Emulsifiable Solvent Cleaning: A wider use of this type of cleaning was made during the year, particularly in spray washer cleaning and for removing buffing compositions previous to alkaline cleaning. To reduce the cost of the cleaning mixture, products have been developed that can be diluted with from 7 to 12 parts kerosene or other cheap solvent, and the mixtures are readily emulsified and washed off by spray rinsing or immersion rinsing. Hand-scrubbing and hand-wiping are said to be eliminated and highly oxidizable metals are not tarnished in the cleaning process.

Alkaline Cleaning: Developments in alkaline cleaning compositions have been numerous. New electrocleaners for *cleaning buffed nickel plate* previous to chromium plate, were announced. An alkaline material for electrolytic *cleaning of base zinc die castings* using reverse current, has been made available. Frequently, a pre-cleaning soaking operation or a degreasing operation precedes the use of the anodic alkaline cleaning.

Another process announced is for the *cleaning of buffed brass and bronze* previous to nickel plating. This process is said to obviate a need for a copper strike before nickel plating, and permits soft soldered work to be bright nickel plated without first copper plating. Brighter and more uniform deposits are claimed with the use of this material.

Several silicate type cleaners were announced for the *cleaning of aluminum and tin*. One material is stated to not affect polished aluminum, even after one hour's exposure to boiling concentration of the cleaner as high as 6 ozs. per gallon.

Because of the trend towards higher current densities used in electrocleaning, *anodes* have been developed, which reduce to a minimum, polarization and resistivity. One type of anode, made of ¼" x 3" steel, features holes punched in alternate rows of 2 and 3. Copper base hooks are welded to the steel electrodes.

Cleaning and handling of bulky parts has been facilitated by new designs of transfer equipment. A *centrifugal washer* which washes, rinses and dries small metal parts in one machine, has been designed. The machine whirls the small parts in a hot detergent solution to remove contaminating materials. For rinsing, the work is spun in the machine while a hot spray of water swirls through the parts. Centrifuging at high speeds under blasts of hot air, dries the parts.

Grinding — Polishing — Buffing

Grinding: Grinding machines developed during the year included machines equipped with variable speed drive, particularly recommended for grinding bulky castings and

heavy duty grinders for bulky work where extra working space around the wheel is required.

Pedestal grinders with 18" and 20" wheel sizes have been marketed which feature a new type wheel guard built according to the A.F.A. standards. It is said to be impossible to jam work between the wheel and the guard.

A *vertical heavy-duty belt grinder* for dry and wet grinding is available for use with grinding speeds from 2400 to 6000 f.p.m. The machine is recommended for squaring, cleaning, burring, facing and polishing operations for removing gates and flashing.

Polishing: The features of polishing machines put on the market during the year are: variable speed with easy speed change, wide overhang, heavy duty ball bearings, better lubrication, V-belt drive and totally enclosed motor and drive mechanism to eliminate difficulty from dust.

A *light duty machine for buffing and coloring* was made available. The power cost is said to be approximately 1 cent per hour.

Automatic equipment for polishing and buffing is usually made to specific classes of work. One machine, for example, made during the year, had a capacity of 900 bumper guards per hour. It was equipped with 8 polishing or buffing heads, featuring full floating spindles to enable the wheels to ride gently over the contour of the work being finished.

To enable proper and efficient application of buffing compositions to buffing wheels, several designs of *composition applicators* were marketed. Applicators are electrically operated and have adjustments to regulate the time and stroke of the application.

The use of *polishing cements* has expanded. One cement announced dries independently of atmospheric conditions. Softening under heat and glaze are eliminated.

A *buffing wheel rake* with easily replaceable teeth was offered to the trade. The teeth have a uniform depth of 3/16" which is said to maintain the best fluff length for the most efficient holding of the buffing composition.

For cleaning of grease wheels used in polishing, *stick pumice* has been offered in round sticks approximately 2½" in diameter and 7½" long. These sticks are reported to give longer life than lump pumice, as well as giving properly cleaned polishing wheel faces.

Polishing Wheels and Buffs: Bias type, and bias type ventilated wheels found increased use, particularly the latter, for automatic buffing where high temperatures must be withstood. Several bias type wheels were offered to the trade.

A *polishing wheel* has been developed that consists of individual buff sections cemented together with a special cement. Improved

operation under high temperatures is reported.

The obtaining of a better head on wheels used for greaseless compositions was made possible by the availability of a *new adhesive*. The adhesive is thinned with water and applied to sewed buffs or polishing wheels by means of a brush, and after drying, the greaseless composition is applied to the wheel in the usual manner. Re-heading, using the new adhesive, is reported to be facilitated.

Soft rubber polishing wheels were announced which are said to have substantial flexibility and which require less than normal pressures to produce the desired finish. The wheels can be dressed to any desired shape.

Scratch brushes with high strength, lightweight alloy metal hubs were offered to the trade. The construction is stated to insure permanently tight tufts and the metal hub obviates danger of warping or splitting. Steel, brass, nickel silver, Tampico bristle and hair brushes are available in this construction.

Buffing Compositions: Grease type compositions developed for special applications have been many. One composition is recommended for buffing of aluminum to produce a high color; another for the buffing of plastics, to produce a smooth high color without burning or tinting of the plastic; another features the use of aluminum which is said to reduce hazard from silicosis and also to facilitate cleaning.

Pickling

The major developments in pickling during the year have been in equipment for bulk pickling. Several types of machines have been designed for this purpose; one employing a vertical lift for transfer of baskets of work from one tank to the next; another type machine employs rotating perforated baskets.

An improvement in pickling is said to be effected by the use of a new addition agent, announced during the year. This addition agent is stated to inhibit attack of the acid on the base metal, to lower the surface tension of the solution to effect faster pickling and scale removal, and to facilitate smooth pickling when the parts are contaminated with oil.

Several designs of dipping baskets were offered; one basket made of 18-8 stainless steel has extra small perforations to replace wire baskets for pickling in nitric and sulfuric acid solutions. A centrifugal wire basket was designed to offer a basket sufficiently strong to withstand centrifuging after pickling. The basket is offered in various corrosion resistant alloys. A line of heavy duty perforated open type baskets was marketed.

Barrel Finishing

Considerable interest was shown during the year on the barrel finishing of plastic parts. Barrel finishing has added significance in view of the desire for increased

production under the armament program. A barrel grinding compound was announced which contains a lubricant and abrasive for the barrel grinding of small steel or non-ferrous parts. Higher lustre and faster operation are claimed.

New style tilting tumbling barrels made from semi-nickel steel were offered to the trade. The barrels feature a patented work-shifting bottom which is securely welded in the inside of the shell forcing the load to shift alternately forward and backward as well as to tumble the work in the revolving barrel.

A new type double cylinder rotary finishing barrel was made available, which is said to be particularly good for tumbling and finishing die castings and stamped metal parts of stainless steel, brass, etc. The units are available for both dry and wet finishing.

A large output barrel plater employing a new hopper principle was manufactured. This equipment is for the cleaning and barrel plating of small parts which are difficult to clean by the ordinary dipping basket method. The parts are run through a cleaning cycle from hopper to hopper, and are finally plated in the same series. Each hopper requires approximately 55 seconds to make a cycle.

Multiple oblique barrel plating units which are said to be ideal for the finishing of small batches of work, such as screws, bolts, nuts, etc. were developed. The units are available in 4, 6, 8 and 10 tub sizes. The barrels are interchangeable, rotating at the same rate of speed at 45° elevation.

Filtration

To facilitate rapid cleaning of filter presses and to reduce costs on disc filtering, a high wet strength paper was offered to the trade which is stated to withstand both acid and alkaline solutions. The discs or plates are cleaned by merely removing the paper.

A specially designed rubber medium was announced for use between the filter plate and filter cloth. The use of this medium is stated to increase the rate of flow, without clogging, to reduce cleaning costs and to give improved clarity to the filtrate.

Several new designs of filter presses were made available; one type utilizes molded, fibrous discs for filtration. The unit is compact, has high filter capacity, is portable and can be made of any corrosion resistant metal desired.

A laboratory horizontal plate type filter for filtering from one pint up, with flow rates from 1 gallon to 150 gallons per hour, was announced. The feature of the filter is that it is suitable for any type filter medium.

A new all-rubber covered cast iron filter press was designed, and a filter press with quick-cleaning features employing back sluicing for cleaning, was developed.

Electrical Equipment

Some developments in electrical equipment for the year included: unique low

voltage generators for electrogalvanizing of steel wire; an automatic circuit interrupter, available in sizes up to 600 ampere capacity for interrupting the current after a predetermined time, and a line of new selenium type rectifiers, which feature high output and efficiency with small size.

Handling Equipment

Several new devices were offered to facilitate handling of products and materials. A shaker separator for separating sawdust, emery, burnishing balls, etc., from small parts, in from 20 to 30 seconds, was announced.

A truck for handling acid carboys was marketed, featuring two arms for grasping the carboys which are controlled by a foot pedal. A drum cradle truck was designed for both transporting drums and permitting easy pouring from the drum as well as easy raising of the drum upon the truck. A suit made of synthetic rubber, which will withstand oil and acid, was offered for use in handling corrosive materials.

Testing Instruments

The Hull cell which enables rapid study of the plating characteristics of solutions over wide current densities was made available to the industry. The apparatus consists of the cell, slide-wire resistance and ammeter.

Two types of pH units were announced; one employs the quinhydrone and calomel electrodes for the pH range from 0 to 8; the other instrument is of the direct reading type and utilizes the sealed glass electrode, which makes it particularly suitable for field or plant work.

The "Magne-Cage" for determining the thickness of electrodeposits magnetically has been improved. The instrument, as now marketed, will measure: (1) nickel coatings on non-magnetic base metals; (2) non-magnetic, metallic or organic coatings on magnetic base metals; (3) nickel coatings on iron or steel.

Rubber Coatings

The use of rubber coatings on tanks and chemical handling equipment increased greatly. Seamless rubber lined pipe and fittings were made available. A method of bonding soft rubber to steel and aluminum was devised and sulfur-free rubber lined tanks for bright nickel and silver plating found increased use. A huge vulcanizer, 15' in diameter, was built to enable the handling of large equipment.

A plasticized polyvinyl chloride paint was announced for painting objects that must withstand severely corrosive conditions. The dried film is hard and resistant to acids, alkalis and oxidizing agents.

Seamless rubber tube type insulating steam joints were also developed. The rubber compound made to resist steam and heat is covered with plies of strong, closely woven duck. The joints are 8" long and built to stand 100 pounds steam pressure.

The Effects of Water Impurities Upon Nickel Deposits

BY MYRON B. DIGGIN

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The impurities, both organic and inorganic, frequently found in water, which may be contributory to considerable difficulty in nickel plating, are described. Mention is made of the concentration of impurities by evaporation of water in the plating solution. Most of the impurities present in water are discussed, and among these are: iron, calcium, magnesium, alkali metals, carbonates, oxygen and suspended matter.—Ed.

WITH the increasing use of high current density nickel solutions, many of which are operated hot and with either air or mechanical agitation, it is important to consider the difficulties which may be caused by the concentration of impurities normally present in varying degrees in all water supplies.

Water Impurities Concentrate

Even in room temperature, low current density nickel solutions, various troubles have been definitely traced to the water used in preparing and maintaining the baths, along with that carried into the baths by drag-in from the preceding rinses. In high current density solutions where bright deposits are produced, or where heavy deposits are being applied, the unfavorable characteristics, which would probably remain unnoticed in low current density baths in which thin deposits are being produced, are more evident. In room temperature nickel baths, the evaporation losses are very small; therefore, little make-up water is required, whereas, in agitated baths operated from 120 to 160°F., the normal solution level is maintained by as many as four additions of water in an eight hour working day. In a 400-gallon air-agitated solution operated at 160°F., as much as 20 gallons of water are required during an eight hour period. This leads to a concentration of the mineral and other constituents originally present in the water, with the result that a soft water will in effect become hard and hard water will become abnormally hard in the plating tank. Obviously, it will require a longer period of operation to build up a high concentration of mineral constituents where soft water is available than in hard water districts where the initial concentrations of minerals in the water are already high.



Myron B. Diggin

The mineral constituents usually present in water supplies are: iron, aluminum, calcium, magnesium, sodium, potassium, hydrogen ions, CO_3^{--} , CO_2 , oxygen, SO_3^{--} , nitrogen (as albuminoid nitrogen, ammonia, nitrites or nitrates) sulphate, chloride and possibly phosphates. In addition to these soluble mineral constituents, certain waters contain suspended matter, such as clay, silt and precipitated iron compounds. Surface waters may contain a very high percentage of organic matter.

Effect of Iron

Iron, either in the soluble or precipitated form, is definitely harmful in nickel plating baths, as it tends to induce pitting and causes the deposits to become hard and less ductile. Nickel anodes not many years ago contained as much as 8% iron and released this iron in the nickel bath upon dissolution. The baths used with these anodes were high pH, low current density types, and the deposits were not subsequently chromium plated. Deposits were not produced to the specifications in effect today, and deposits were in most cases thinner than are now required. In the high pH baths, the iron precipitated, and as few loads were run through the tank during the day, the precipitate remained quietly on the bottom of the tank.

With the advent of chromium plating and the more rigid specifications calling for increased thicknesses and

protective values, it was necessary to modify plating solutions in order to obtain more adherent and more protective deposits and at the same time apply the metal at a faster rate. These requirements resulted in the use of warm baths and the various bright nickel processes, all of which are more sensitive to iron contamination. Anode manufacturers have produced nickel anodes with an extremely low iron content for use with these solutions.

Nearly all water contains small amounts of iron. Where the conditions are especially serious in respect to the concentration of this element, provisions are made at municipal or private water stations to remove a large proportion by aeration or other treatments. There have been a few instances where iron in the water supply has caused difficulties, but in most cases iron has been introduced into the bath from other sources, such as, impure salts, from the attack of steel work dropped to the bottom of the tank, or from adding water which has been standing in iron pipe which has not been recently flushed.

Aluminum

Aluminum in high pH nickel solutions hydrolyzes along with iron and can be removed by filtration. This element does not affect the deposit directly, but may cause porosity in the coating in the same manner as any other suspended matter. In low pH baths, operated under a pH of 4.0 electrometric, aluminum apparently has little effect. The addition of aluminum sulphate in concentrations up to 0.5 oz. per gallon to a commercial bright nickel solution did not in any observable manner affect the deposits, if the pH were not permitted to rise above 4.4.

Calcium

Calcium, which is originally present in water as a carbonate or bicarbonate, is converted to calcium sulphate in acid nickel solutions. This salt is slightly soluble and is unusual in that it is less soluble in hot than in cold solutions. Calcium apparently does not affect the character of nickel deposits directly. To determine the effect of this element, a filter press serving a 2000 gallon warm nickel solution was charged with calcium sulphate and the bath circulated over the cake for several days until a saturation was obtained. The deposits at the end of this period were tested and found to be entirely satisfactory.

Within the past year, several nickel solutions which have given trouble have been examined and long white, needle-like crystals have been observed on the bottom of the sample bottles. Upon analysis the crystals were found to be 90-96% calcium sulphate. In each case the solutions originated in hard water districts and were warm solutions requiring considerable quantities of make-up water. In one case, several electric immersion heaters used to heat the bath burned out. An examination of the heater showed that a hard brownish-white insulating film covered the units, thus causing overheating. The deposit was found to be calcium sulphate which is a principal constituent of boiler scale and is known to lower heat transfer tremendously. Where

a nickel solution is saturated with calcium sulphate and further additions of calcium-bearing water are added, precipitation occurs. This would also take place with temperature changes in a saturated solution.

The effect of calcium sulphate precipitation is often unnoticed in dull plating solutions, but is manifested in bright nickel baths by spotted deposits, generally on surfaces in a horizontal plane. These spots appear to be similar to pits, although in most cases, a distinct nucleus can be observed under low power magnification. It is obvious that corrosion resistance will be lowered by this condition.

Magnesium

Magnesium is another hardness producing constituent found in water in varying degrees and concentrations. Examinations made of hundreds of nickel baths of all types and from various locations indicate that this element is invariably present. In some baths the magnesium sulphate concentration was unusually high. In a majority of these cases, it was established upon inquiry that Epsom salts (magnesium sulphate) additions had been made, either when originally preparing the bath or periodically to maintain a definite magnesium sulphate concentration.

Magnesium sulphate, unlike calcium sulphate, is very soluble; therefore, precipitation difficulties do not arise. Epsom salts additions to nickel solutions are claimed to produce softer deposits, to minimize certain types of pitting, and to increase throwing power. Recent tests made on one of the commercial bright nickel baths indicate that throwing power is increased and that there is a definite softening of the deposits. It is known that magnesium sulphate additions increase cathode polarization and lower the resistivity of a nickel bath.

Alkali Metals

Sodium and potassium ions are carried into plating solutions by water additions, but the exact concentration is seldom determined because of involved analytical procedures. Sodium and potassium chlorides or sulphate have excellent solubilities; therefore, there is no danger of precipitation occurring. However, these alkaline metal ions are considered undesirable in most modern warm and bright nickel solutions where the softest and most ductile deposits are desired.

pH of Water

The hydrogen ion concentration or the pH of natural water varies considerably in different localities and may cause a rapid change in the pH of a poorly buffered nickel solution. There are cases on record where highly alkaline waters have necessitated several pH adjustments of the nickel bath during a single day, especially where articles were being plated which carried in large quantities of water from the previous rinsing operations.

Carbonates

Carbonates introduced into the nickel bath from

rinse or make-up waters are decomposed with the release of CO_2 gas. Carbon dioxide is also present as dissolved gas in water. E. A. Anderson¹ made a study of the effect of carbon dioxide and carbonates in nickel baths and found that they caused a very definite embrittling effect leading to edge cracking of the deposits. Carbon dioxide will not be absorbed from the atmosphere in sufficient quantity to initiate cracking, and it is this investigator's opinion that the only sources to be encountered in practical work would be from the use of air agitation in cold solutions, from carbonates present as impurities in plating salts, and carbonates used in solution purification. It is stated that given a reasonable time, any carbon dioxide in the solution will be reduced on simple standing to below the threshold value require to initiate cracking. These tests were made in a solution with a pH of 5.45 to 5.8. Reduction of the pH and increase in solution temperature would favor a more rapid removal of any carbon dioxide present.

Oxygen

Gaseous oxygen is apparently not harmful in nickel baths as air agitation is frequently used and oxygen is released to some extent at the anode, both conditions leading to a higher oxygen content than would normally be introduced by water. Likewise, nitrogen in the elemental form is harmless, although albuminoid nitrogen, nitrites and nitrates are definitely undesirable. Nitrates have a tendency to promote pitting, especially in low pH baths.

Under certain conditions dissolved air in a plating bath will promote pitting. A warm nickel solution allowed to become cold over a week-end frequently produces pitted deposits the first few hours at the beginning of the week. Heating the cold bath lowers the solubility of the dissolved air which is released from solution and tends to collect on the surface of the work being plated. This condition leads to badly pitted work. In air agitated or other vigorously agitated solutions the gas bubbles are swept from the cathode surface before they can cause pitting. In cases where filtration is being conducted while plating, a filter press which is not tight will aspirate enough air to produce pitting in an unagitated nickel bath.

Other Impurities

Sulphates and chlorides are normally present in nickel baths, and, therefore, are not harmful in water supplies. Their presence in large amounts, however, indicates equivalent quantities of positive radicals which may be detrimental to the operation of the bath.

Suspended matter, whether it be clay, silt or precipitated iron compounds, is definitely harmful when admitted to a plating bath from the water supply. Fortunately, most water stations have modern and efficient filters which produce water of high clarity. Often when heavy demands are made on a distribution system, rust and silt in the mains are disturbed and will be carried along to the plating tanks, causing rough and porous deposits with a relatively low protective value².

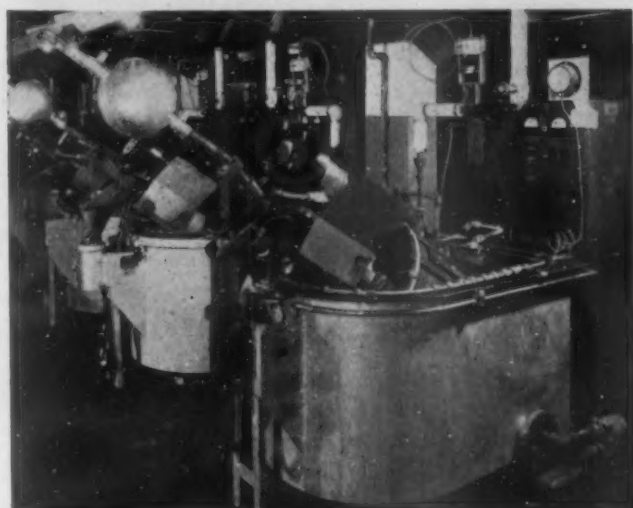
Water taken from a dead end distributing main may be of different composition than where there is good circulation and a higher rate of flow. When such a condition exists, the taps should be opened in the morning and a stream allowed to flow for several minutes before the water is used in plating baths or in rinse tanks.

Organic matter is generally low in concentration in potable water supplies. In many plants surface water from ponds, etc., is used for the plating room supply. Cases have been recorded where the pH of brook and lake water was as low as 3.0. This has been traced to decomposing vegetation at the head waters of the stream. Aside from the unusual acidity, such water contains organic matter which is detrimental to nickel baths, particularly bright nickel solutions.

In general, water supplies are remarkably pure, but under modern plating conditions the effect of impurities, especially when they become concentrated in the baths as outlined above, should be understood so that the sources of plating difficulties can be more easily located and the proper corrective measures employed. A future article will describe the treatment of water for plating purposes and the elimination of water-borne impurities already present in the plating baths.

1. E. A. Anderson—Proc. A.E.S. 1936, p. 185.

2. Hothersall & Hammond—Trans. A.E.S., Vol. LXXIII, p. 449 (1938).



Closeup of one of the 12 tanks for high speed electroplating at a temperature of 180 degrees Fahrenheit being used in the plant of the Westinghouse Electric & Manufacturing Company in Newark, N. J., lined with the recently announced Triflex "K" rubber tank lining by The B. F. Goodrich Company, Akron, Ohio. This lining has been especially developed for this type of service, and is non-contaminating and completely resistant to the corrosive effects of plating solutions. Ordinarily rubber or synthetic rubber linings have a decided tendency to throw the delicate baths used off-balance.

A Study of Rhodium Plating

PART III—CONCLUSION

By Mark Weisberg

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This is the concluding portion of "Study of Rhodium Plating." The results of experiments on the rhodium phosphate baths are given. The study includes the effects of free acid concentration upon cathode current efficiency, effects of rhodium concentration upon cathode current efficiency and effects of current density and temperature upon cathode current efficiency. Commercial rhodium plating practice is also discussed.

Discussion of Results on Rhodium Phosphate Baths

AS STATED previously, the most widely used rhodium phosphate plating bath today contains 0.2% rhodium (as metal) and 5% free phosphoric acid. Therefore, the investigation centered about this bath. First, quantitative data were obtained showing the effect of current density and temperature on the cathode current efficiency from baths of constant rhodium content but whose acidity varied. Runs 1-84, illustrated in Figs. 6-A and 6-B show the quantitative effect of phosphoric acid concentration on the cathode current efficiency when the bath contains 0.2% rhodium as metal. In every case, the data show clearly that the current efficiency increases with a decrease in the free phosphoric acid content of the bath. Data for a 1.0% acid solution showed similar results but are not included in the table of data or curves because, in no case, were the results in the bright plating range.

Data listed in runs 13-24 and 85-120, plotted in Figs. 7-A and 7-B, show the effect of rhodium concentration on the current efficiency, in each case for a bath containing 5% free phosphoric acid. In every case it will be noted that the cathode current efficiency increases with increasing rhodium concentrations. It will be noted, further, that the commonly used concentration of 0.2% rhodium is about the maximum safe concentration to use with a 5% free acid bath; the 0.3% solution gives plates which are somewhat inferior and the 0.4% solution produces results which are distinctly inferior in physical appearance.

The data plotted on curves 6-A, 6-B, 7-A, 7-B all show the effect of current density and temperature upon the current efficiencies. However, as in the case of the sulfate baths these data have been replotted in Figs. 8 and 9 to show, directly, the quantitative effect of cathode current density and temperature upon the current efficiencies. So many data were available for these sets of curves that only representative curves were plotted. However, the data in every case show (a) that the cathode current efficiency will increase with an increase in temperature and (b) that increasing the current density will decrease the cathode current efficiency.

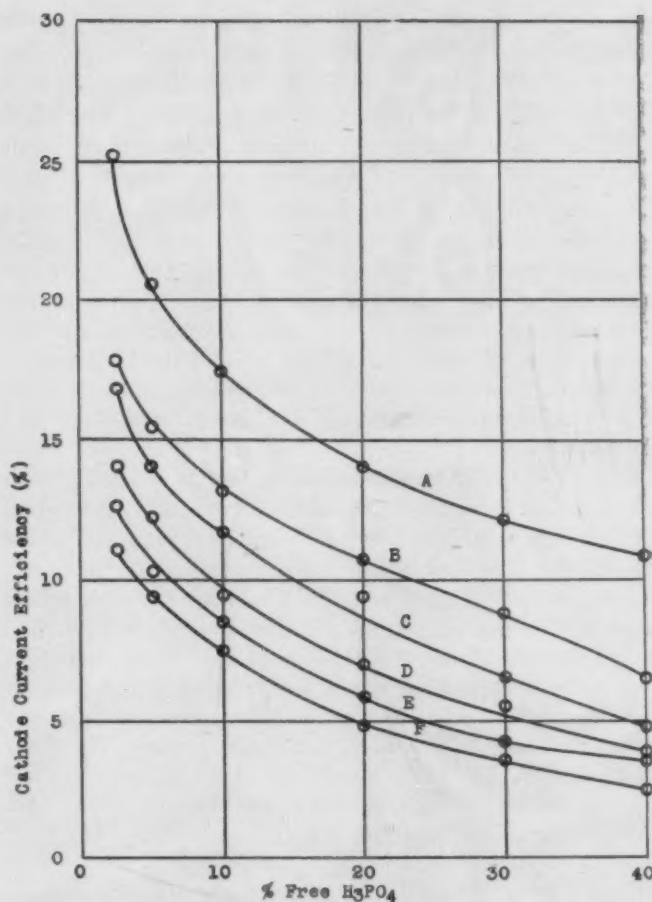


Fig. 6-A. Effect of free acid concentration upon cathode current efficiency of a rhodium phosphate plating bath containing 0.2% rhodium as metal.

Curve A: 0.25 c.d., 150°F.	Curve D: 0.25 c.d., 85°F.
Curve B: 0.5 " 150°F.	Curve E: 0.5 " 110°F.
Curve C: 0.25 " 110°F.	Curve F: 0.5 " 85°F.

For the studies of the phosphate baths a study of the porosity of the deposit was made in most cases. As stated previously, it consisted of noting the time required for discoloration of a drop of nitric acid applied to the surface of the deposit. At first glance, the data listed in table II look quite erratic. However, one must realize that such a test is meaningless unless one knows the depth of the deposit. These studies were made on deposits of varying thickness as well as of varying physical character. To be of any accuracy, the tests should be made on samples having the same thickness of deposit. Qualitatively, the

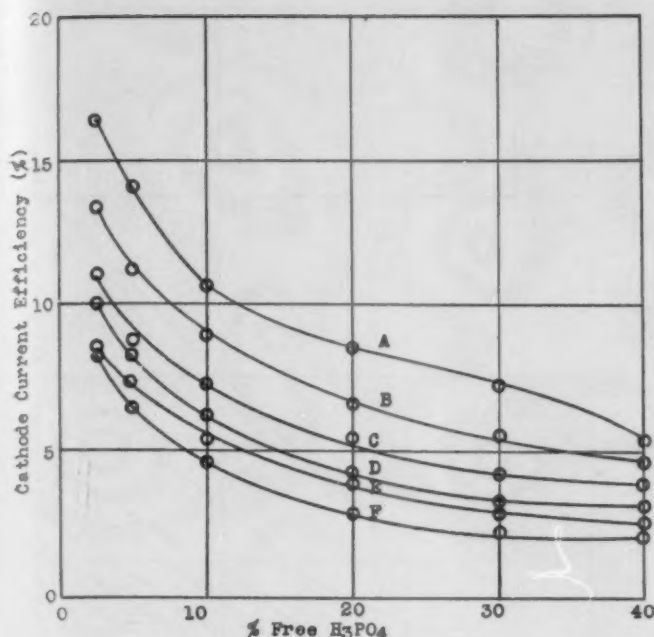


Fig. 6-B. Effect of free acid concentration upon cathode current efficiency of a rhodium phosphate plating bath containing 0.2% rhodium as metal.

Curve A: 0.75 c.d., 150°F. Curve D: 1.0 c.d., 110°F.
 Curve B: 1.0 " 150°F. Curve E: 0.75 " 85°F.
 Curve C: 0.75 " 110°F. Curve F: 1.0 " 85°F.

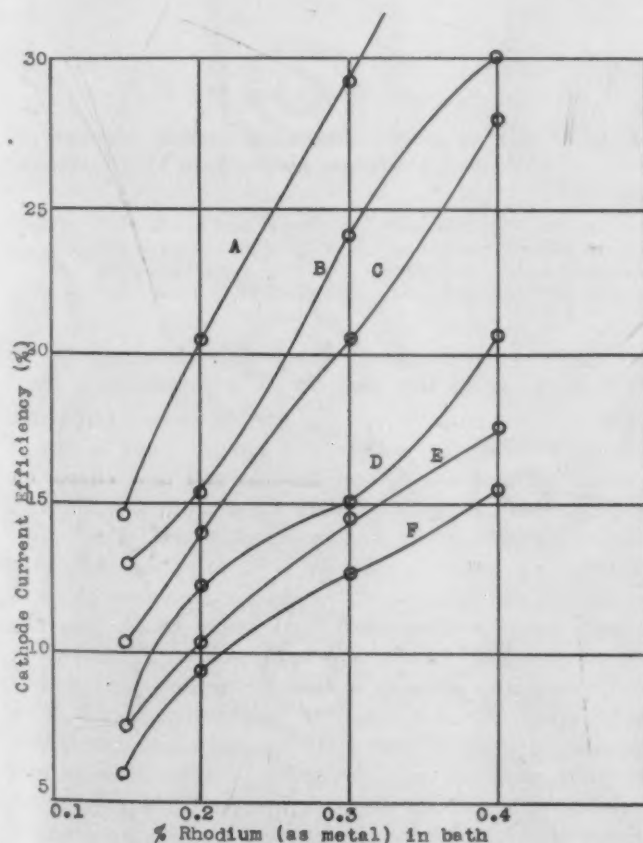


Fig. 7-A. Effect of rhodium concentration upon cathode current efficiency of a 5% free acid rhodium phosphate plating bath.

Curve A: 0.25 c.d., 150°F. Curve D: 0.25 c.d., 85°F.
 Curve B: 0.5 " 150°F. Curve E: 0.5 " 110°F.
 Curve C: 0.25 " 110°F. Curve F: 0.5 " 85°F.

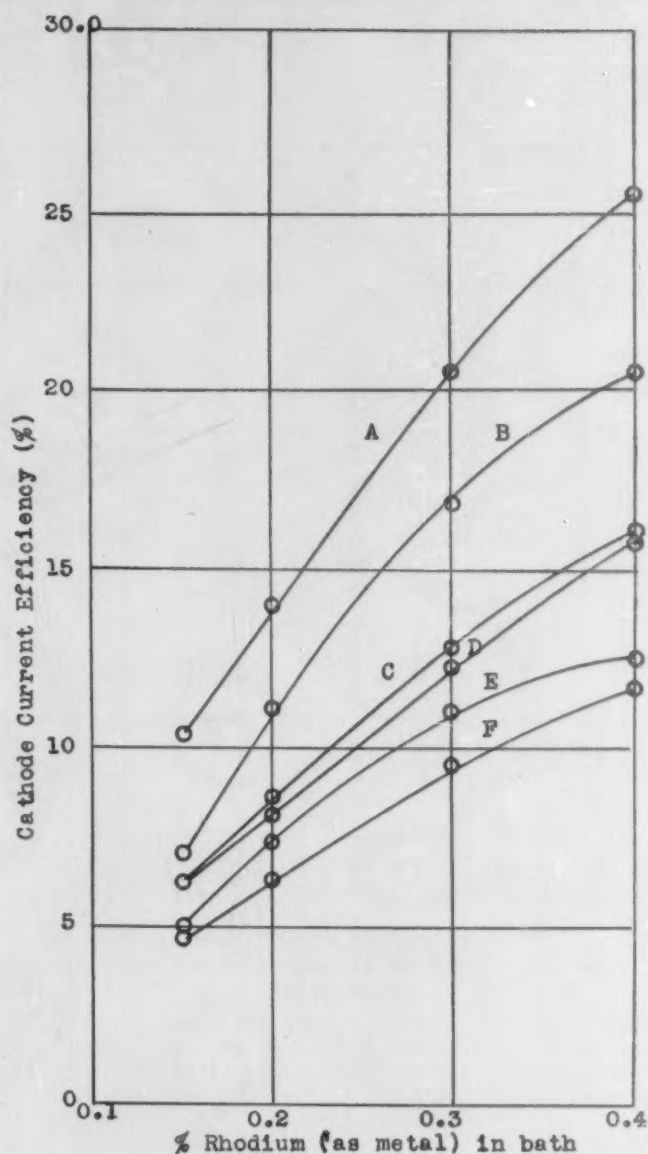


Fig. 7-B. Effect of rhodium concentration upon cathode current efficiency of a 5% free acid rhodium phosphate plating bath.

Curve A: 0.75 c.d., 150°F. Curve D: 1.0 c.d., 110°F.
 Curve B: 1.0 " 150°F. Curve E: 0.75 " 85°F.
 Curve C: 0.75 " 110°F. Curve F: 1.0 " 85°F.

data do show that the resistance to corrosion, as measured by this porosity test, increases with increasing depths of deposit and that a gray deposit (listed in the table as—poor—) is really superior in corrosion resistance to the bright shiny deposit. However, these last mentioned observations are merely suggestions for further work along this line. With the data given it should be relatively simple to predict how long a deposition should continue to produce a deposit of a specified thickness (in terms of weight of rhodium) and in that way produce deposits upon which corrosion or porosity tests might be made that would be significant. Lack of time prevented this study here.

Conclusions

1. The cathode current efficiency of rhodium plating baths, both phosphate and sulfate, increases with a decrease in the free acid concentration of the bath. In each case, the present practice specifies acidities not much in

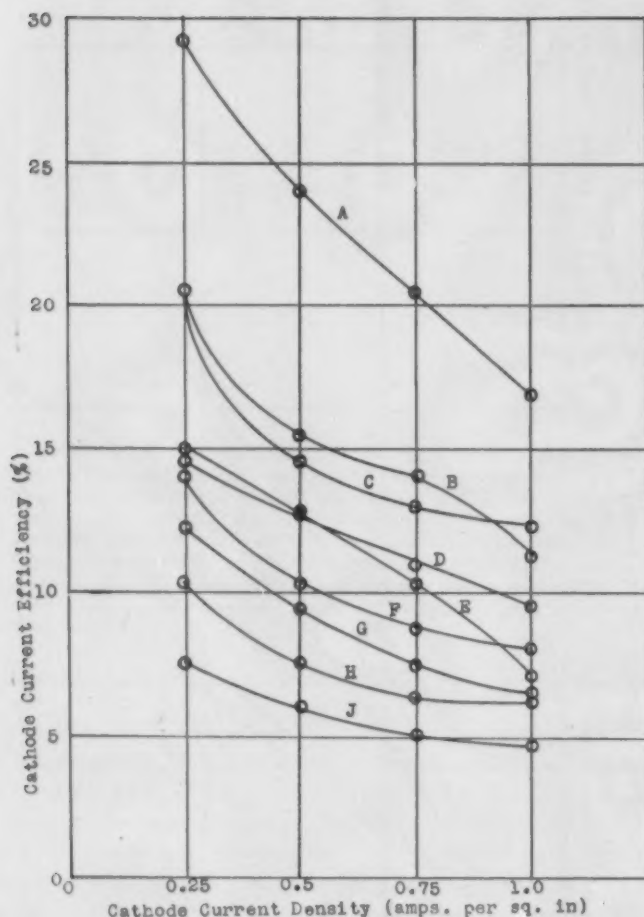


Fig. 8. Effect of current density upon cathode current efficiency of a rhodium phosphate solution containing 5% free H_3PO_4 .

Curve A: 0.3% Rh, 150°F.	Curve E: 0.15% Rh, 150°F.
Curve B: 0.2% " 150°F.	Curve F: 0.2% " 110°F.
Curve C: 0.3% " 110°F.	Curve G: 0.2% " 85°F.
Curve D: 0.3% " 85°F.	Curve H: 0.15% " 110°F.
Curve J: 0.15% Rh, 85°F.	

excess of requirements to hold that operation in the safe bright range.

2. The cathode current efficiency of rhodium plating baths, both phosphate and sulfate, increases with an increase in the rhodium metal content of the bath. The concentrations specified are now nicely in balance with the specified acid concentrations to maintain the operation in the safe bright plating range.

3. The cathode current efficiency of rhodium plating baths increases with a decrease in current density and with an increase in temperature.

Commercial Rhodium Plating Practice

In the preceding study an attempt was made to give as complete a picture of the historic development of rhodium plating as possible, some quantitative experimental data, and the behavior of rhodium sulphate and phosphate solutions.

To complete the record it seems advisable to discuss at some length the actual commercial practice in installing and maintaining a rhodium solution, the various types of merchandise which are rhodium plated, types of cells and control instruments used, as well as methods of handling

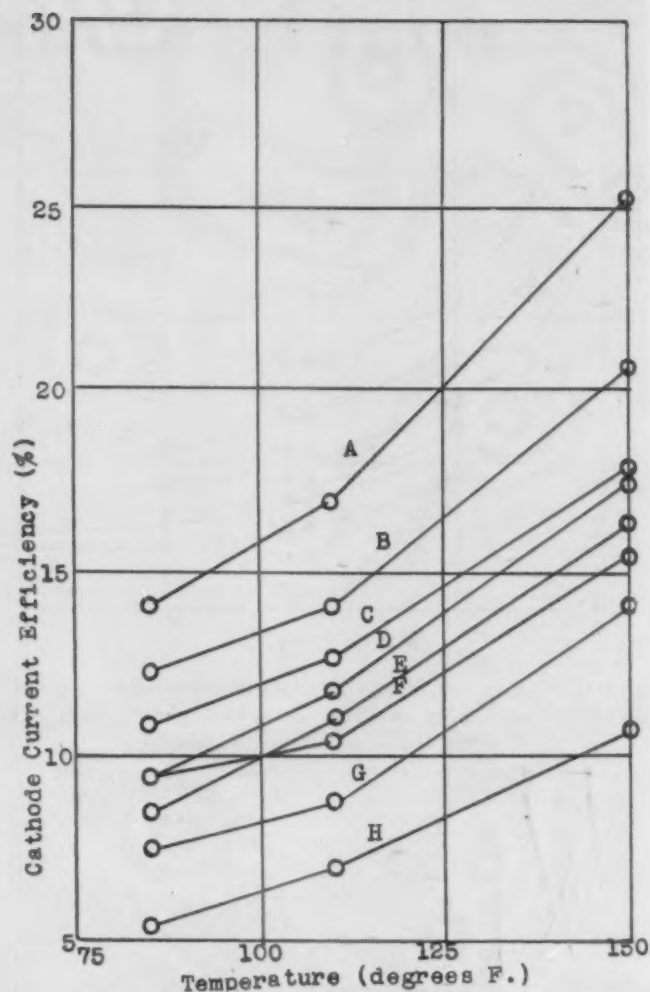


Fig. 9. Effect of temperature upon cathode current efficiency of a rhodium phosphate plating bath (0.2% rhodium as metal).

Curve A: 0.25 c.d., 2.5% acid	Curve E: 0.75 c.d., 2.5% acid
Curve B: 0.25 c.d., 5.0% acid	Curve F: 0.5 c.d., 5.0% acid
Curve C: 0.5 c.d., 2.5% acid	Curve G: 0.75 c.d., 5.0% acid
Curve D: 0.25 c.d., 10.0% acid	Curve H: 0.75 c.d., 10.0% acid

work to be rhodium plated, and, finally, some figures on cost and utility of the rhodium as a protective coating.

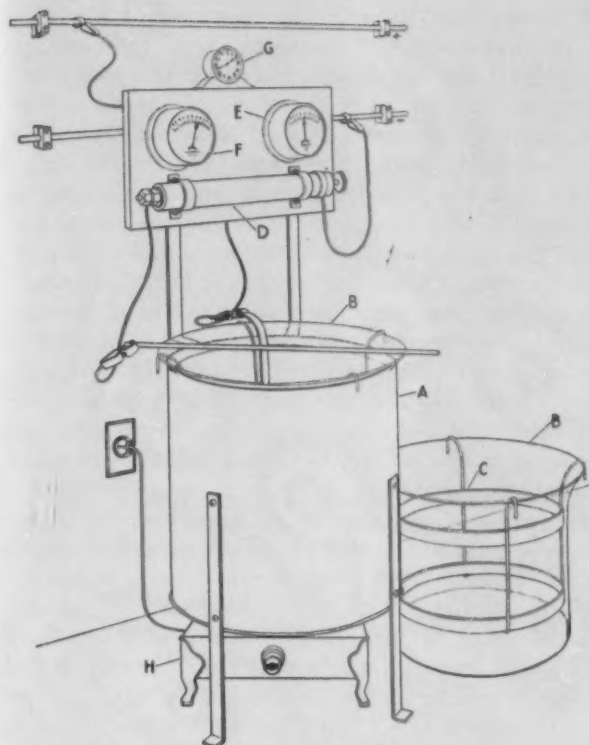
The jewelry industry was the first to embrace rhodium plating. In fact, the jewelry and novelty trade is always in search of new colors, new finishes and new effects for the decoration of metals to make them more saleable and, therefore, is always the first to adopt a new plate. This industry, for instance, was the first to adopt chromium plating, and this metal was in vogue for a number of years, or until the time when chromium began to be generally used on plumbing fixtures and automobiles. At this point milady rightfully rebelled against decorating herself with a color which she also found on her kitchen faucets. This happened in spite of the fact that the chromium finish was quite excellent from the point of view of wear and durability. It must be observed, however, that the intense blueness of chromium and the fact that it was not a precious metal did not appeal to the jewelry industry from the start, but up to that period no better white was obtained. For decades this industry was searching for a white electroplated coating which would be durable and easily applied by the method of flash plating. Nickel was too dull and yellow; silver, the superb white metal, tarnished too

TABLE II. *Data for Rhodium Phosphate Baths*

Run no.	Time sec.	% Rh in bath	% H_2PO_4 in bath	Cathode current density amps/sq. in.	Temp. °F.	Current efficiency %	Character of Deposit Seconds porosity	appearance
1	60	0.2	2.5	0.25	85	14.0	2	excellent
2	60	0.2	2.5	0.25	110	16.8	4	excellent
3	60	0.2	2.5	0.25	150	25.2	25	excellent
4	60	0.2	2.5	0.5	85	10.8	5	excellent
5	60	0.2	2.5	0.5	110	12.6	17	excellent
6	60	0.2	2.5	0.5	150	17.8	95	good
7	60	0.2	2.5	0.75	85	8.5	6	excellent
8	60	0.2	2.5	0.75	110	11.0	72	excellent
9	60	0.2	2.5	0.75	150	16.3	110	good
10	60	0.2	2.5	1.0	85	8.2	30	good
11	60	0.2	2.5	1.0	110	10.0	55	good
12	60	0.2	2.5	1.0	150	13.3	130	good
13	60	0.2	5.0	0.25	85	12.2		excellent
14	60	0.2	5.0	0.25	110	14.0		excellent
15	60	0.2	5.0	0.25	150	20.5		excellent
16	60	0.2	5.0	0.5	85	9.4		excellent
17	60	0.2	5.0	0.5	110	10.3		excellent
18	60	0.2	5.0	0.5	150	15.4		excellent
19	60	0.2	5.0	0.75	85	7.5		excellent
20	60	0.2	5.0	0.75	110	8.7		excellent
21	60	0.2	5.0	0.75	150	14.0		good
22	60	0.2	5.0	1.0	85	6.3		excellent
23	60	0.2	5.0	1.0	110	8.1		excellent
24	60	0.2	5.0	1.0	150	11.2		good
25	60	0.2	10.0	0.25	85	9.4	0	excellent
26	60	0.2	10.0	0.25	110	11.7	20	excellent
27	60	0.2	10.0	0.25	150	17.5	20	excellent
28	60	0.2	10.0	0.5	85	7.5	0	excellent
29	60	0.2	10.0	0.5	110	8.5	4	excellent
30	60	0.2	10.0	0.5	150	13.2	15	excellent
31	60	0.2	10.0	0.75	85	5.3	3	excellent
32	60	0.2	10.0	0.75	110	6.9	7	excellent
33	60	0.2	10.0	0.75	150	10.6	35	good
34	60	0.2	10.0	1.0	85	4.2	7	excellent
35	60	0.2	10.0	1.0	110	5.9	25	excellent
36	60	0.2	10.0	1.0	150	8.9	48	good
37	60	0.2	15.0	0.25	85	8.4	0	excellent
38	60	0.2	15.0	0.25	110	10.2	0	excellent
39	60	0.2	15.0	0.25	150	16.0	10	excellent
40	60	0.2	15.0	0.5	85	6.1	2	excellent
41	60	0.2	15.0	0.5	110	7.0	3	excellent
42	60	0.2	15.0	0.5	150	11.2	12	excellent
43	60	0.2	15.0	0.75	85	5.0	3	excellent
44	60	0.2	15.0	0.75	110	6.3	22	excellent
45	60	0.2	15.0	0.75	150	9.4	12	good
46	60	0.2	15.0	1.0	85	3.5	5	excellent
47	60	0.2	15.0	1.0	110	4.4	7	excellent
48	60	0.2	15.0	1.0	150	7.5	45	good
49	120	0.2	20.0	0.25	85	7.0	2	excellent
50	120	0.2	20.0	0.25	110	9.4	6	excellent
51	120	0.2	20.0	0.25	150	14.0	40	excellent
52	120	0.2	20.0	0.5	85	4.7	5	excellent
53	120	0.2	20.0	0.5	110	5.8	25	excellent
54	120	0.2	20.0	0.5	150	10.7	40	excellent
55	120	0.2	20.0	0.75	85	3.8	8	excellent
56	120	0.2	20.0	0.75	110	5.3	50	excellent
57	120	0.2	20.0	0.75	150	8.4	70	good
58	120	0.2	20.0	1.0	85	3.0	5	excellent
59	120	0.2	20.0	1.0	110	4.2	60	excellent
60	120	0.2	20.0	1.0	150	6.5	80	good

TABLE II. (continued). Data for Rhodium Phosphate Baths

Run no.	Time sec.	% Rh in bath	% H_2PO_4 in bath	Cathode current density amps/sq. in.	Temp. °F.	Current efficiency %	Character of Deposit	
							Seconds porosity	appearance
61	120	0.2	30.0	0.25	85	5.3		good
62	120	0.2	30.0	0.25	110	6.3		good
63	120	0.2	30.0	0.25	150	12.2		good
64	120	0.2	30.0	0.5	85	3.5		good
65	120	0.2	30.0	0.5	110	5.0		good
66	120	0.2	30.0	0.5	150	8.8		good
67	120	0.2	30.0	0.75	85	2.8		good
68	120	0.2	30.0	0.75	110	4.2		good
69	120	0.2	30.0	0.75	150	7.2		poor
70	120	0.2	30.0	1.0	85	2.2		good
71	120	0.2	30.0	1.0	110	3.2		good
72	120	0.2	30.0	1.0	150	5.5		poor
73	120	0.2	40.0	0.25	85	3.8	0	poor
74	120	0.2	40.0	0.25	110	4.7	0	poor
75	120	0.2	40.0	0.25	150	10.8	10	poor
76	120	0.2	40.0	0.5	85	2.4	2	poor
77	120	0.2	40.0	0.5	110	4.5	2	poor
78	120	0.2	40.0	0.5	150	7.0	50	poor
79	120	0.2	40.0	0.75	85	2.5	2	poor
80	120	0.2	40.0	0.75	110	3.8	8	poor
81	120	0.2	40.0	0.75	150	6.5	40	poor
82	120	0.2	40.0	1.0	85	2.0	3	poor
83	120	0.2	40.0	1.0	110	3.0	15	poor
84	120	0.2	40.0	1.0	150	4.5	30	poor
85	120	0.15	5.0	0.25	85	7.5	5	excellent
86	120	0.15	5.0	0.25	110	10.3	10	excellent
87	120	0.15	5.0	0.25	150	14.5	40	excellent
88	120	0.15	5.0	0.5	85	6.0	6	excellent
89	120	0.15	5.0	0.5	110	7.5	20	excellent
90	120	0.15	5.0	0.5	150	12.9	95	excellent
91	120	0.15	5.0	0.75	85	5.0	15	excellent
92	120	0.15	5.0	0.75	110	6.3	35	excellent
93	120	0.15	5.0	0.75	150	10.3	185	good
94	120	0.15	5.0	1.0	85	4.7	30	excellent
95	120	0.15	5.0	1.0	110	6.2	45	excellent
96	120	0.15	5.0	1.0	150	7.1	240	good
97	60	0.3	5.0	0.25	85	15.0		good
98	60	0.3	5.0	0.25	110	20.5		good
99	60	0.3	5.0	0.25	150	29.2		good
100	60	0.3	5.0	0.5	85	12.7		good
101	60	0.3	5.0	0.5	110	14.5		good
102	60	0.3	5.0	0.5	150	24.0		good
103	60	0.3	5.0	0.75	85	11.0	good	good
104	60	0.3	5.0	0.75	110	13.0		good
105	60	0.3	5.0	0.75	150	20.5		poor
106	60	0.3	5.0	1.0	85	9.6		good
107	60	0.3	5.0	1.0	110	12.2		good
108	60	0.3	5.0	1.0	150	16.9		poor
109	60	0.4	5.0	0.25	85	20.6	6	poor
110	60	0.4	5.0	0.25	110	28.0	25	poor
111	60	0.4	5.0	0.25	150	40.0	45	poor
112	60	0.4	5.0	0.5	85	15.5	20	poor
113	60	0.4	5.0	0.5	110	17.5	30	poor
114	60	0.4	5.0	0.5	150	30.0	107	poor
115	60	0.4	5.0	0.75	85	12.5	18	poor
116	60	0.4	5.0	0.75	110	16.0	55	poor
117	60	0.4	5.0	0.75	150	25.5	155	poor
118	60	0.4	5.0	1.0	85	11.8	20	poor
119	60	0.4	5.0	1.0	110	14.8	70	poor
120	60	0.4	5.0	1.0	150	20.5	165	poor



A Four Gallon Rhodium Bath.

A—Copper Water Bath
B—Pyrex Container
C—Platinum Anode
D—Rheostat
E—Voltmeter
F—Ammeter
G—Interval Timing Clock
H—Heater

readily; tin, which gave a beautiful white and was the nearest approach to silver, was too soft and had no wearing quality at all. It is, therefore, understandable, why the jewelry industry received rhodium plating with gratitude. Here at last was a precious metal, more costly than gold or platinum, which gave a bright deposit with the minimum amount of control. The beautiful white color of deposited rhodium on small and broken surfaces nearly equalled that of silver and, in addition, it was acid-proof, perspiration-proof, durable and non-tarnishing. It also showed many other advantages; it enhanced the beauty and brilliance not only of diamonds but of rhinestones and other white stones. It could also be plated from a bath that was nearly foolproof as it required no rigid controls as to composition, temperature, current density, or time of plate. Only one precaution was found necessary and that was to exercise great care to avoid any type of impurity from entering the bath. Being a strongly acid bath it will dissolve a good many base metals, and the presence of very small quantities of these metals, such as nickel, tin, zinc or copper, will destroy the brilliance of the white color or actually give a black deposit. This also holds true with organic impurities or cleaning solutions which might inadvertently be carried into the rhodium bath.

The jewelry industry now uses rhodium plating almost universally to enhance the beauty of white gold and platinum items. The majority of all rhinestone jewelry, which is generally made of a tin alloy, is rhodium plated. In fact, this branch of the industry has greatly expanded because rhodium made it possible to design and put on the market bracelets, clips and necklaces which rival in beauty similar items made of platinum and set with diamonds. These articles do not tarnish or lose their brilliance over long periods of wear. Sterling silver jewelry, whether finished

in antique or not, is quite generally rhodium plated, as well as are many items made of brass and copper.

Other industries allied to the jewelry industry soon realized the advantages of rhodium and adopted its use. The small watch industry now uses rhodium plating on most of the intricate parts of the watch movements, as they have found it to be of considerable advantage in the accurate working of a watch. The optical goods industry has adapted rhodium plating on practically all white optical frames, whether they are made of white gold or nickel silver. Silver deposited designs on glassware are also rhodium plated and, in fact, the tarnish protection which rhodium gives to such items has been a boon to this industry.

One of the largest applications of rhodium has developed in the reflector field. Rhodium plating is being used extensively on reflectors for commercial, scientific and military uses. The advantages of rhodium plated reflectors are many:

1. The deposit is hard and not easily scratched.
2. The coating is durable under adverse weather conditions, such as salt sprays.
3. It is unaffected by high temperatures of the arc lights.
4. It is non-oxidizable.
5. It is unaffected by sulphur and other fumes.
6. The deposit is bright and does not require after-polishing.
7. It has a high specular reflection over a wide color range.
8. The reflectivity value in the visible spectrum, which is nearly 80%, remains constant over a long period of time.

For further details on rhodium plating on reflectors, the reader is referred to the Bureau of Standards Research Paper No. 1168* and to Products Engineering, August 1935 (Rhodium Surfaces for Metal Reflectors, by Blasius Bart).

Such items as scientific instruments, tips for hypodermics and laboratory weights are now, to some extent, being rhodium plated.

There are many other articles which are rhodium plated but no attempt was made here to enumerate them all.

Due to the high acidity and sensitivity of the rhodium bath to many metallic impurities, plating cells are generally of pyrex glass, silica, crockery, or vitreous enameled stoneware. The common practice in the jewelry industry, for instance, is to use a twelve litre pyrex jar placed in a copper or steel water bath. Anodes are pure platinum sheets of about .005" to .010" in thickness. The temperature is maintained between 100 to 120° F. and a current density of 18 to 36 amps per square foot is used.

Larger baths are utilized in cases where the items to be plated are of larger size. In the plating of reflectors, for instance, baths up to a 400-gallon size are used. Such baths are usually of the sulphate type. Lead-lined tanks can be used, the tank serving as anode also. Lead anodes, however, cannot be used with the phosphate type of bath.

The ordinary instruments for temperature and current control are used on all rhodium baths. In addition, a timing device is a very useful instrument as the cost of the metal and the short plating time preclude guess work.

A rhodium bath has excellent throwing power. Silver loving cups of 4" to 5" deep can be rhodium plated inside thoroughly without an auxiliary anode. Therefore, no racks

*Spectral Reflectivity of Rhodium, by W. W. Coblenz & R. Starr.

or special wiring are necessary. Generally 20 to 24 gauge copper wire is used for suspending articles to be plated in the rhodium bath. No tight connections are necessary nor is the spacing of the work too important except for solid articles. Small items, such as screws, rivets or settings, can be plated in baskets or small barrels.

A nickel preplate is generally used to enhance the beauty, brilliance and whiteness of rhodium. The thickness of this preplate depends on the metal plated. In the case of tin alloys, a heavy plate is required as tin is readily affected by acids and, if not properly preplated, the rhodium plate may strike through and cause a streaky deposit. The usual plate on this metal is 20 to 30 minutes. A preplate of 3 to 5 minutes is adequate for brass, copper and precious metals. Some platinum and white gold articles are plated direct in the rhodium bath but, while this practice will produce a good rhodium plate, it is still recommended that a nickel preplate be used at all times.

The ordinary cleaning methods and precautions used for nickel or gold plating are sufficient for rhodium plating, but it is advisable to make sure that the last water rinse, prior to entering the rhodium bath, is very clean, or is, preferably, distilled water. Distilled water is preferred for this last rinse as a rhodium bath is made up of distilled water, and a tap water rinse may possibly be contaminated with cleaning solutions or foreign metals.

The time of plate varies, of course, with the type of item being plated. On jewelry items, or so-called inexpensive costume jewelry which is worn only periodically, a light plate of 15 to 30 seconds will give excellent results. An optical frame or a watch attachment, on the other hand, require a plate of 2 to 3 minutes. Reflectors, of course, require an even heavier plate.

From the quantitative data presented previously in this article, a set of conditions for a rhodium bath can be selected to give the desired plate. For instance, on the cheaper lines of jewelry, where economy and speed are essential, a high acid, low temperature, low rhodium concentration and high current density solution is used. All of these factors favor bright flash deposits at the least expense. On the other hand, in the optical and reflector industries, as well as in higher priced jewelry, the factors are selected in the bright plating range which will give high current efficiency and a heavy plate at a given time.

Many jewelry items of the popular type are not being rhodium plated due to a misconception of cost. In spite of the fact that rhodium, as supplied to the user, is much higher in price than gold, rhodium plating can be done as cheaply as, or even cheaper than, gold plating. If we base the average efficiency of a rhodium plating bath at 7%, a one-minute plate at 36 amps per square foot would cost about 30c. However, since a 15 to 20 second plate is sufficient on cheaper items and since a current density of much less than 36 amps per square foot is used, the advantages of rhodium plating can be secured at a cost of about 10c per square foot—which is certainly not higher than the cost of gold plating.

It is of prime importance to mention, at this point, that the expense of rhodium plating is often caused by poor installation, lack of care of the bath and, particularly, the lack of proper set-up of drag-out tanks to save all the rhodium possible. Jewelry items, in particular, are often of intricate design—many are ball, cup-shaped or pierced affairs—and the area on such pieces is hard to figure, is often misleading, and the chances of occluded rhodium solu-

tion by capillary attraction in these designs is very great. If this rhodium is not recovered, more rhodium may be dragged out into the waste waters than is actually used for plating the articles. It is, therefore, of interest to conclude this article with the record of a 12-litre bath in the maintenance of which intelligent care and supervision were used.

This bath was installed in 1932 and an accurate record was kept of every item plated. One and one-half to two and one-half million pieces were rhodium plated in this 12 litre bath per year. During this period of 1932-1940 nearly fifteen million pieces were plated and the cost of the rhodium that has gone through this bath amounted to about \$70,000. The bath, as originally installed, contained 20 grams of rhodium sulphate solution, 480 grams C. P. sulphuric acid and 12 litres of distilled water. Four platinum anodes, each of 16 square inches in area, were used and the articles plated varied from one-quarter inch to two square inches in area. After five years' operation of the same bath, the accumulation of sulphuric acid due to hydrolysis and the introduction of sulphuric acid which is contained in excess in prepared rhodium solutions which were used in replenishing the bath, became so great that the density of the bath made it difficult to submerge the light work to be plated. On analysis the bath proved to contain 55% sulphuric acid and 3 grams of rhodium per litre. Since the bath still operated satisfactorily, it was decided to remove the excess of sulphuric acid by neutralization of part of the bath, washing out the sodium sulfate so formed and recovering the rhodium as hydrate. The rhodium hydrate was then returned to the bath where it was dissolved by the sulphuric acid and reconverted to rhodium sulphate. This practice has been adopted as a regular procedure and is done every two months to maintain the acid content. The entire set-up is neatly arranged. Accurate temperature controls are used, and a system of drag-out tanks is so arranged that not a drop of the rhodium solution is lost. Of course, the conditions of temperature, current density, acidity and rhodium concentration were selected to give a good bright rhodium plate, giving satisfactory protection at a minimum of cost. This care resulted in a saving to the manufacturer of over 30% in the amount of rhodium used for the same amount of work that was plated prior to these improvements. It will be realized that a 30% saving on \$70,000 is well worth while.



The Jessop Steel Co., Washington, Pa., has recently installed a large drum type grinding and polishing machine shown above for finishing sheets and plates up to 50 inches wide by 14 feet long, of any type metal.



Bells Through The Ages

"If bells have any sides, the clapper will find 'em"

Ben Jonson

By Joseph Danforth Little

Nutley, N. J.

This is the concluding portion of the article, the first part of which appeared in the December 1940 issue of Metal Finishing.

POE, Milton, Wordsworth, Tennyson, Gray, Longfellow, Browning and Schiller have all sung of bells and all literature is loud with music of bells. The famous Leaning Tower of Pisa, which leans thirteen feet from perpendicular, and which seems to be in the very act of falling as one looks upon it, has one of the most beautiful Campaniles in the world consisting of 7 bells, the heaviest of which weighs six tons and hangs on the side opposite the overhanging wall. The structure is 180 feet high and is crowned by a belfry, which contains the bells. This strange phenomenon has existed for over five hundred and ninety years, it having been built in the year 1350. In spite of political and religious differences and in spite of attacks upon the church, which are frequently bitter, all classes of the community would feel that something was lacking if, amid the general rejoicing, the sound of bells did not peal out, with jubilant clangor from the church steeples, as if to give voice to the joy so evident around them. In early English days, it seems to have been customary for the bell man at Christmas time to go amongst the householders of his district giving each a copy of his broadside and expecting something from each in return, some small gratuity, as an addition to his ordinary wages. One of these closes with the following:

*"May heaven preserve your families from hence
Until another Christmas doth commence
And by His Providence you always keep
When I have laid my sounding bell to sleep."*

Bells of America

In the early days of New England settlements, congregations were called to church either by the beating of a drum, the blowing of a tin horn or a conch shell, or by raising a flag, for bells were conspicuous by their absence. At Hingham, Mass. where the question of buying a bell came up, the Puritans voted "a church bell is a contrivance of priests, not suitable for our meeting house. We will consider the use of the drum". America's early colonists were too greatly occupied with more serious problems to practice the bell founding art, and the first bells used by the colonies were brought from Europe. Only a few of these have been preserved.

Records show that Harvard College had a bell in a turret in 1643. Probably the oldest English bell in this country now in use is one in the Court House at Barnstable, Mass. The date of 1765 appears on it. It originally belonged to the First Parish Church in Sandwich, Mass. After the sale of the church, the bell came into the possession of the County Court House.

A bell now preserved in a church in Passaic, N. J. was cast in Holland in 1700. The original bells of Trinity Church in New York City were cast in England about 1700 and were said to have been the gift of Queen Anne to that church. The oldest bell in the United States and probably the oldest in both Americas, hangs in the small village of East Haddam, Conn. and bears the date of A. D. 803. It probably came from an old monastery in Spain and may have been brought to this country as ballast in some sailing vessel.

In some of the old church records of this country harking back to the seventeenth century, are accounts of the purchase and installation of clocks and bells, some to be paid for in grain and others in commodities by assessment against the town's citizens. In all the tinnabulation of bells, there is none the world over, that in its symbolism, has had a greater effect on civilization than the bell which rings out tidings of great joy. Such was the effect on the people of Philadelphia when the grand old Liberty Bell, so intimately associated with the beginning of our Republic, rang out its message and summoned the colonists to hear the first official reading of the Declaration of Independence. Next to our flag, this famous bell seems to evoke the most ardent outbursts of patriotic feeling.

Though not the largest nor the oldest bell in America, the Liberty Bell is by far the most celebrated and most famous bell in this country. It is one that is of interest to every American citizen. It is dedicated to the cause of liberty and it actually "Proclaimed the liberty" of the thirteen states, as its tones on July 8th, 1776 (not on July 4th) rang out the birth of a Nation and announced to all the world, that a new republic had been born, a few days before and the Colonies of America were free and independent as the first official reading of the Declaration of Independence was read from a balcony in the State House square. Thus it fulfilled the Biblical quotation which appeared on the side of the bell, "Proclaim Liberty through all the land unto all the inhabitants thereof—Levit. XXV, 10".

When the American forces left Philadelphia in 1777 this bell was moved by the patriots to Allentown, Penn., where it would be beyond danger of coming into the hands of the British army and of being transmuted into cannon

for use against the Continental army. The removal took place with great secrecy in the dead of night and to make assurance, the hallowed bell was placed on an old farm wagon, where it lay ignominiously hidden under a huge load of manure. At Bethlehem, Penn., the chariot of Liberty collapsed and its freight had to be transferred to another vehicle, which managed to complete the journey to Allentown. This event is prosaically mentioned in the records of the Moravian Church at Bethlehem under the date of September 23, 1777. The bell arrived at Allentown and was secreted under the floor of Zion Reformed Church and remained there until the latter part of 1778 when the evacuation of Philadelphia by the British permitted its return to the belfry in Independence Hall in the City of Brotherly Love.

Bells Made of Various Metals

CONSIDERING briefly the metallurgy of bell-metal, the alloy best suited for the purpose is one of copper and tin. Bells have been made of aluminum, bronze, silver, gold, glass, wrought iron and even of wood, but the accepted alloy of copper and tin is the one in general use. Old French bells were often made of iron, while brass was more commonly employed in England. Bells found at Ninevah were usually of bronze. A small one was recently discovered in that ancient city which was found to be of 86% copper and 14% tin.

Hand bells are still made of every kind of sonorous metal, including gold and silver, according to the fancy of the maker or buyer. Glass has been employed for a long period of time. Occasionally a little zinc and lead are also added. A higher percentage of tin improves the tone but renders the metal brittle and therefore more liable to crack. Too much copper softens the alloy and impairs the tone in consequence. The oft-mentioned addition of silver would have the same effect as too much copper. Steel bells have been made but they have not been entirely satisfactory.

Bell-metal, as now understood, consists of copper and tin, proportions vary to some extent, but the accepted alloy and common standard is three parts copper to one part of tin on small or medium sized bells and on large ones, four parts copper to one of tin but the brittleness of the material, renders them liable to crack.

A popular superstition was that a bell of specially sweet tone, owes its excellence to the presence of a quantity of silver and gold in its composition and that on account of its presence there, the bell had great purity of tone. This is a great error. Experts tell us that the employment of silver and gold in any appreciable quantity would have the precisely contra effect upon the tone and would tend to injure it.

It has been said that the legend arose from the practice among the workmen engaged in the casting, of asking bystanders for silver coins to throw into the molten metal, on the plea that thus the composition would be improved. In the time of Henry II the proportion was two of copper to one of tin. The tone of a bell depends not only upon the composition of metals from which it is made, but also upon the shape and the relation of the proportions of height, diameter, and thickness.

Today, bell manufacturing is a highly specialized industry. In 1732, one Henry Bayley advertised his readiness "to cast any rings of bells in the town they belong." The

bell founder did not always devote himself to that work only, but combined it with some more or less analogous trade. Sometimes the second trade taken up was strangely incongruous with the other. For example, one bell founder was entrusted with repairing the organ; another, Roger Kent by name, who lived in England in the sixteenth century, made cloths and bells. Another supplemented his bell casting by selling wine. In the records of the parish of Winlock, Shopshire, England, is an account of the death of Sir William Corvehill, which reads: "priest of the Service of our Lady in this Church. He was skilled in geometry, not by speculation, but by experience—he could make organs, clocks and chimes, in kerving in masonry and silk weaving and painting and could make all instruments of music and he was a very patient and gud man. All this country had a great loss of Sir William, for he was a good bell founder and maker of frames."

The Greatest Bell That Man Ever Made

Some of the most celebrated bells have achieved fame principally on account of their size and weight, while others have been accounted noteworthy, having played an important part in history. The Russians have surpassed all other nations in the magnitude of their scale of bell founding.

Superstitions Concerning Bells

From the very earliest times, much superstitious feeling was connected with bells. There are in some countries, places which are pointed out where church bells have fallen into a lake or river, or have sunk deep into the ground, will toll on certain days of the year or on solemn occasions. The believers in these wonders go to the place where a bell is said to be hidden and listen attentively. Generally they soon hear the distant sounds which they anxiously wish to hear.

In early days a belief became prevalent that bad luck came to any one destroying a bell and that a ship carrying a stolen bell would never reach shore. An anecdote of the Middle Ages tells of a band of robbers who, having broken into a Monastery out of bravado, rang a peal of bells. A miracle was wrought holding them tight to the ropes from which they were unable to free themselves. Some held that evil spirits hated and feared the sound of church bells and that they could be put to flight by the ringing of bells. No longer ago than 1852, the Bishop of Malta ordered the church bells to be rung for one hour "to lay a gale of wind." In France, up to a few decades ago, it was not unusual to ring the church bells to ward off lightning.

In Sweden there is an old bell bearing an inscription which reads: "I serve God, defy lightning and mourn the dead." At one time, bells were supposed to have real virtue and it was believed by many and even by some at the present day, that they had the power to help when in danger and that they prayed to God for the living and also the dead and that bell ringing, on the approach of a thunder storm, was a protection against destruction by lightning, thunder and tempest and that bell ringing would avert pestilence. One writer held that "the passing bell was anciently rung for two purposes; one to speak the prayers of all good Christians for a soul just departed; the other to drive away the evil spirits who stood at the bed's foot and about the house, ready to seize their prey, or at least to molest and terrify the soul in its passage."

SHOP PROBLEMS

Faulty Acid Copper Solution

Q. We have, for some time, been having trouble with our acid copper plating bath. A continuous brown smut forms on our anodes and apparently falls into the solution and plates out on the work causing rough plating, not to say anything about the fact that this also heavily contaminates the solution.

Our tank is a lead-lined, steel tank—36" x 36" x 30" deep. We use five bars, two cathode and three anode bars. The anodes are rolled copper, elliptically shaped and 26" long x 1" thick. Three anodes are hung on each anode bar, making nine altogether. Our work is racked—three pair of shoes on each rack, six racks making a full load. We plate at 1½ to 2 volts and 30 to 40 amperes per sq. ft. We also agitate our solution with air, the source of which is a small spraying compressor.

We specialize in the metallization of baby shoes only. This type of work, as you probably know, is processed by dipping into paraffine wax first, followed by a dip in shellac and then sprayed with copper bronze powder for conductivity. We are using Drakenfelds "Extra Dry Copper Powder".

We recently acquired a filter with which we filtered our solution. We first treated the solution with activated carbon, allowed same to settle out over-night and then filtered into another tank. We thoroughly cleaned the original tank and filtered back into same.

We now find that the filtering of the solution has not eliminated the trouble, since the brown smut still forms on the anodes.

We are, therefore, taking the liberty of submitting to you samples of our solution and the brown smut, in the hope that with the above facts you could possibly advise us as to the cause and a way of overcoming this most aggravating trouble.

Anything you could do to help us would, we can assure you, be sincerely appreciated.

A. The smut is primarily finely divided metallic copper. A test was made to determine if much of the smut is composed of copper oxides, but if these are present, it is in only a small amount.

The solution showed the following analysis:

Copper sulfate	33.9	ozs./gal.
Sulfuric acid	8.4	"

Your trouble is due principally to poor anode corrosion. You state you are using rolled anodes and presumably these are

Technical Advisor For January Issue

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of a good standard grade. Assuming this, that is, assuming that the anodes are of high purity and uniform grain structure, then you have two other factors that are first on the list with regard to affecting the type of corrosion: First, solution composition; Second, anode current density. (Solution temperature, agitation, impurities, are also factors).

With regard to solution composition, you are running the acid somewhat lower than has been found to give good results with a copper sulfate content of 34 ozs./gal. For an air agitated solution and 33 ozs./gal. of copper sulfate, about 10 av. ozs./gal. of sulfuric acid is best. That is, best for rapid deposition with good anode corrosion. You may have found that the high acid is not good in your case due to attack of the inside of the shoes or damage to the metallizing before copper covers the shoe. If this is the case you can do one of two things. After metallizing the shoes, give them a first coat of copper in a separate tank low in acid, then follow in the high acid tank. Or, use just one solution, but use a formula in the neighborhood of 27 ozs. of copper sulfate and 6.5 av. ozs. of sulfuric acid per gallon. This formula should give you better anode corrosion.

With regard to anode current density, it is known that if it is too low, metallic particles will form. At a higher current density, the anode will come down cleaner and smoother. Too high a current density will cause coating over, and excessive polarization.

Definite figures have been obtained on this in the case of nickel anodes by McDuffie & McFarlane in their report presented to the 1939 convention of the American Electroplaters' Society.

Specifically therefore, we suggest you try cutting down the anode area in your tank. If removing any anodes spreads them out so much that poor distribution results, then use the same number of anodes, but shorten them.

If for any reason you cannot do the above, or change the solution composition, then you will have to use anode

bags. There is no entirely satisfactory material for this purpose. Wool, glass cloth, and synthetic fibre cloths have been used.—G. B. H., Jr.

Asphalt-Lined Tank for Silver Plating

Q. Under separate cover, we are sending you a bottle of silver solution to be analyzed. This solution is used for plating copper wire and was made up according to formula in the Guidebook. It was used in a steel tank that was lined with some form of asphalt, and was made for us by a plating supply house.

At one end of the tank, the asphalt has broken away and the silver anodes are being used up nearly twice as fast as the anodes at the other end of the tank.

We are to re-line this tank with a rubber lining and would like to know if the solution, after it is filtered, will be satisfactory to use over again.

A. The analysis of your solution is:

Silver	3.97	tr. ozs./gal.
Free sodium cyanide	1.83	av. ozs./gal.

The metal content is at a good figure, but the free cyanide would be considered low for normal plating procedures. Unless you run a low free cyanide for some special reason, add 1¼ ozs./gal. of sodium cyanide. This addition should be made gradually.

The solution is contaminated with dirt and impurities. The extent of the contamination, especially the dissolved metals such as copper, would determine whether this solution was suitable for use again.

It is suggested you filter the solution, and add the cyanide as directed. (If much solution is lost during the filtration requiring the addition of much water a check analysis should be made). A test run can be made and the quality of plating noted. The decision can then be made as to whether to continue use of the solution before going to the expense of making any metal additions.

Poor contacts at the anode rod will cause uneven distribution of current to the anodes and can be the cause of the more rapid corrosion of some anodes. The use of heavy steel anode rods, placed just under the surface of the solution, and from which the anodes are suspended by short hooks, will eliminate contact uncertainties.

If a rubber lining is contemplated, make certain that the rubber is compatible with a silver plating solution. Plain steel tanks (left coated with the mill scale)

are successfully used for holding silver plating solutions. Keep anodes about 3" away from the side of the tank. If closer, put wired glass between anodes and side of tank.—G. B. H., Jr.

Calculation of Sulphuric Acid

Q. This inquiry refers to the determination of sulphuric acid as described on page 101 of the 1940 edition of Plating & Finishing Guidebook. I always work out my answer by the number of ccs titrated from NaOH solution by multiplying with the factor given, thus obtaining the result in ounces per gallon. What I would like to know is how does ounces per gallon compare to percentage. In other words, is there any set rule for converting ounces per gallon of sulphuric acid into a percentage reading.

A. The percent by weight of sulfuric acid will be equal to the weight of sulfuric acid multiplied by 100 and divided by the weight of one gallon of the solution.

The weight of the solution in ounces is equal to 133 multiplied by the specific gravity (133 avoirdupois oz. in 1 gal. of water).

Therefore the percentage equals:

$$\% = \frac{\text{oz./gal. sulfuric acid} \times 100}{133 \times \text{sp. gr. of solution}}$$

$$= \frac{0.75 \times \text{oz./gal. sulfuric acid}}{\text{sp. gr. of solution}}$$

The specific gravity of the solution may be determined by a hydrometer graduated in density units, commonly called a specific gravity hydrometer.

If only a Baume hydrometer is available, which is commonly the case in most shops, the equivalent specific gravity may be determined by examination of a hydrometer conversion table in almost any chemical or engineering handbook or by the use of the following formula:

$$\text{sp. gr.} = \frac{145}{145 - \text{Baume}}$$

—G. B. H., Jr.

Nickel-Rhodium Plated White Metal

Q. We are sending to you a sample of nickel solution and also a sample of work that has been nickel, and finally, rhodium plated. The base metal is a tin alloy which was cleaned in the usual commercial way, consisting of soap cleaning to remove the rouge, electro-alkaline cleaning, 2% hydrochloric acid dipping, rinsing, etc., and then nickel plating for from 5 to 10 minutes. You will note that the plate is brittle. The pH of the solution is 5.8.

Will you please let me know the difficulty with the solution?

A. Your nickel solution has been analyzed and shows:

Nickel	2.78 ozs./gal.
Chloride as ammonium chloride	3.24 "
pH	6.5

The nickel and chloride are all right, but the pH is too high. Correct by adding sulfuric acid in the proportion of 2¼ fl. ozs. of sulfuric acid to each 100 gallons of plating solution. An addition of ½ oz./gal. of boric acid should then be made.

It is believed that most of your trouble comes from overcleaning. The base metal with which you are working is very susceptible to attack by alkaline cleaners. The cleaning time in alkaline cleaners should therefore be held at a minimum. Have the piece as clean as possible before going into the cleaners so that long immersion and scrubbing are not necessary.

Remove the rouge by means of a degreaser or solvent such as kerosene, carbon tetrachloride, or trichlorethylene. Absorb off the solvent in sawdust; do not allow it to dry on the work. The piece should now be clean enough so that not more than 2 or 3 seconds in the electric cleaner is required. The length of time in the cleaner should be such that good cleaning is had yet none of the original luster of the surface be lost. The surface of the piece should not be discolored, and should have the same luster as it had after coming from the wheel.

—G. B. H., Jr.

Spotted Oxidized Finish

Q. We are sending you under separate cover, one steel stamping finished in bronze, and have drawn a circle around the defects in this finish. Our procedure of finishing is as follows:

One greaseless wheel operation
Brass plate
Oxidize in liver of sulphur solution
Dry in sawdust
Wire brush
Brush with loose rag wheel
Buff lacquer

Will you kindly advise what these defects are and what causes them?

A. Examination of the spots under the glass shows that each one has a black speck at the center.

It is believed that source of your trouble is sulfide particles, settling on the work, or applied there by the scratch brushing action. Keep finished work covered, or away from department where scratch brushing is being done.

In cleaning work after greaseless operation, it is advisable to soak work in water before going into the alkaline cleaner. The water will remove any glue that is left on the work from leave-off marks from the wheel. Alkaline cleaners

often do not remove, but sometimes harden, particles of glue that may be left on the work, and these will cause pores in the subsequent brass deposit.

Suggest you obtain a copy of "The Spotting of Plated or Finished Metals," by W. P. Barrows. Bureau of Standards Research Paper No. 72. Obtainable from the Supt. of Documents, Wash., D. C., for 10c cash.—G. B. H., Jr.

Spotted Watch Dials

Q. We are troubled with the formation of dark spots in the centers of dials for watches. The dials are also frequently corroded and stained. We are uncertain as to whether this is being caused by an unsuitable lacquer and do not know whether the spots are cyanide or sulphide spots, or are caused by corrosive conditions. Is it possible that the cellophane in which they are packed may have caused this trouble?

A. The spots are under the lacquer, and the following are suggested as possible sources of your trouble.

1. Incorrect rinsing, and drying out, before lacquering.

The rough grain finish makes removal of viscous solutions, such as cyanide solutions, difficult. Rinse thoroughly, and make certain last rinses are in clean water. If alcohol is being used for drying out, check to see that its water content has not built up too high. It is also suggested that a check be made to see that dials are not handled on the face after drying out and before lacquering.

2. It is further suggested that the dials be given a slightly heavier deposit. This can be done by giving the dial a light 24K gold flash, and then a flash in the karat gold solution. A karat gold flash direct can not afford good protection against corrosive conditions, due to its porosity. Also, the rough finish of the base metal requires a heavy electrodeposit to give a relatively non-porous coating. Check plating solution.

3. To answer your question on the cellophane, it is possible that this may be the source of your trouble. To check on this, lacquer a few dials with several coats of lacquer, and place in cellophane bags. These dials should not spot as much as dials with the usual lacquer coating, if the cellophane is causing the spots.—G. B. H., Jr.

The shop problem service is not intended to be a routine, free analytical service. Advice is freely given on problems which cannot be solved by the inquirer. Only simple plating solution analyses will be made free of charge.

ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—FINISHING—RUST PROOFING—LACQUERING

Corrosion Inhibitor

U. S. Patent No. 2,220,059. H. A. Beekhuis & C. K. Lawrence, assignors to The Solvay Process Co. November 5, 1940. The corrosion of ferrous metals in ammoniacal solutions of inorganic salts is reduced by the addition of a trivalent arsenic compound in amounts of about 0.05% or more calculated as As_2O_3 . For even better protection, a compound which contains divalent sulfur linked to carbon may be added, preferably with the sulfur linked to an atom of carbon with the remaining valences of the carbon atom linking the carbon to nitrogen. Examples are carbon disulfide, thioalcohols, thioethers, thiocyanates etc. Amounts used are equivalent to 0.04% sulfur. The inhibitor is especially good for ammonium nitrate solutions of from 40-80% concentration dissolved in ammonia of greater than 5% concentration.

Electrolytic Printing Cylinders

U. S. Patent No. 2,217,015. I. Gurwick & R. A. Jennings, assignors to Shellmar Products Co. October 8, 1940. A method of forming intaglio printing cylinders, which comprises providing a steel base cylinder of a uniform diameter slightly less than the desired diameter, smoothing the surface of said cylinder and electrodepositing thereon a coating of iron about 0.003-0.005" thick about 3 amperes per square inch, requiring 12 volts, while rotating at about 200 feet per minute peripheral speed, polishing the iron surface and then subjecting the iron surface to an etching process.

Combination Cleaner, Flux & Solder

U. S. Patent No. 2,216,928. S. B. Wilson. October 8, 1940. A material comprising a soldering flux, an ammoniate and a material selected from a fusible metal or alloy. A cleaning and soldering powder comprising a mixture of 10-50% by weight of ammonium chloride, 10-50% by weight of zinc ammonio chloride, and 10-50% by weight of a powdered solder.

Ex.: NH_4Cl 25% by wt.
 $ZnCl_2 \cdot 5NH_3$ 25% " "
 Plumbers solder 50% " "

White Alloy Deposit

U. S. Patent No. 2,216,605. S. Sklarew & L. Cinnamon, assignors to Special Chemicals Corp. October 1, 1940. A process of electrodepositing a white copper, cobalt, tin alloy plate using an aqueous alkali cyanide bath containing copper salts, cobalt salts and tin salts, the quantities of said salts being such that the metallic contents of one gallon of

said solution will be from about 0.04-15.85 grams copper, from about 0.02-9.2 grams cobalt and from about 0.02-3.6 grams tin and having a free alkali cyanide content of from 0.3-6 oz./gal. of solution.

The deposit is claimed to be corrosion resistant, hard, ductile, high in reflectivity, good throwing power and is not absorbed by zinc so that it may be used as a base plate on zinc base alloys.

Potassium ferrocyanide may be used to partially replace the sodium cyanide, such as in amounts from 1-10 grams per liter. Various additions may be made to increase brightness and conductivity, a list being given in the patent.

Ex.: All are dry weights to be used with 1 gallon of solution.

1. Sodium stannate	8.60 g.
Sodium cyanide	90.00 "
Copper cyanide	18.00 "
Cobalt carbonate	5.80 "
2. Sodium stannate	8.60 g.
Sodium cyanide	90.00 "
Copper cyanide	18.00 "
Cobalt carbonate	5.80 "
Rochelle salt	1.25 "
3. Sodium stannate	8.60 g.
Sodium cyanide	90.00 "
Copper cyanide	18.00 "
Cobalt carbonate	5.80 "
Rochelle salt	1.25 "
Trisodium phosphate	7.60 "
4. Sodium stannate	8.60 g.
Sodium cyanide	90.00 "
Copper cyanide	18.00 "
Cobalt sulfate	13.80 "
Rochelle salt	1.25 "
Trisodium phosphate	7.60 "

One gram per gal. of bone glue or 0.1 g./gal. of dextrose, goulac, or sodium thio-sulfate are some of the brighteners listed.

Coloring Iron & Steel Black

U. S. Patent No. 2,217,586. G. Zapf, assignor to Bernhard Berghaus (Germany). October 8, 1940. An improvement in coloring of iron and steel black using the caustic soda-sodium nitrate solution which in this instance may also be used on cast iron. The color is produced in three stages requiring three baths:

First Bath:

Caustic soda	73-77%; Preferably 75%
Disodium phosphate	14-22%; Preferably 16.5%
Sodium nitrate	3-7%; Preferably 5%

Immerse for 15 min. at 125-135°C. (preferably 128°C.) in 60 parts of above mixture dissolved in 40 parts of water.

Second Bath:

Caustic soda	50-70%; Preferably 60%
Sodium nitrate	30-50%; Preferably 40%

Immerse for 15 min. at 130-138°C. (preferably 133°C.) in 60 parts of above mixture dissolved in 40 parts of water.

Third Bath:

Caustic soda	55-70%; Preferably 60%
Disodium phosphate	8-12%; Preferably 10%
Trisodium phosphate	10-18%; Preferably 14%
Sodium nitrate	2.5-4%; Preferably 3%

Immerse for 30 min. at 145-160°C. (preferably 150°C.) in 60 parts of above mixture dissolved in 40 parts water.

There may be added to Bath I, 0.5% sodium iodate; to Bath II, 0.5% potassium iodide; and to Bath III, 0.5% sodium iodate and 4% soda ash.

Bright Zinc Plating

U. S. Patent No. 2,218,734. L. R. Westbrook, assignor to E. I. du Pont de Nemours & Co. October 22, 1940. A brightener in a cyanide zinc bath consisting of a compound containing a methylenedioxyphenyl group, also with the addition of a metal from the group consisting of molybdenum, chromium, cobalt, manganese, nickel, iron, titanium, rhenium, aluminum and tungsten. Brighteners are: piperonal, piperonyl alcohol, piperonylic acid, piperine, safrole, piperonal acetophenone. Molybdenum is best metal and is used to the extent of 1-12 g./l. preferably. When making up the solution, 2.5 g./l. zinc dust is added to purify the bath. The deposit is dipped in a solution of ¼% nitric acid for 15 seconds. Example of solution:

Zinc cyanide	60 g./l.
Caustic soda	78 "
Sodium cyanide	42 "
Molybdenum trioxide	8.0 "
Piperonal	3.5 "

Coloring Zinc Black

U. S. Patent No. 2,219,977. O. Brill, assignor to Firm Mannesmann-Stahlblechbau, A. G. (Germany). October 29, 1940. Zinc is coated black in an improved molybdate bath by immersion. Patent claims the process of coating articles consisting at least superficially of zinc, comprising the steps of

treating the articles with a solution of a heavy metal sulfate, selected from the group consisting of chromium, cobalt and nickel sulfates, from which the metals may be deposited on the zinc upon immersion of the surfaces in said solution and thereafter treating said article with a molybdate solution, while maintaining the hydrogen ion concentration of the solution at a value of about pH = 5 by means of suitable buffers such as sodium acetate and acetic acid, or tartaric acid and sodium tartrate.

Example: Zinc or zinc coated metal is dipped at room temperature for about 1/2 min. in a solution of 10-15% copper sulfate plus 1% acetic acid. The article is rinsed and dipped in the molybdenum solution. The first dip may contain 10-15% nickel sulfate plus 1% acetic acid instead of copper sulfate plus acid, but a 1 min. immersion at room temperature is required.

The coloring solution contains the following:

Ammonium molybdate 0.5- 5%
Tartaric acid 0.1-0.5%
Temperature = 50-60°C.
Immersion for 3-6 min.

Pickling Tank

U. S. Patent No. 2,216,544. O. S. True & E. R. Beecher, assignors to United States Rubber Co. October 1, 1940. A rubber coated pickling tank with supporting members.

Pickling Machine

U. S. Patent No. 2,216,211. S. Nyberg & H. C. Cappel, assignors to Agnes J. Reeves Greer. October 1, 1940. A method and machine for pickling metal in coils while rotating the coils on a mandrel.

Protection of Ferrous Metals

Protection of Ferrous Metals. U. S. Patent No. 2,215,092. H. A. Beekhuis, Jr. & W. deForest Macomber, assignors by mesne assignments to The Solvay Process Co., Sept. 17, 1940. Corrosion of ferrous metals in an ammoniacal ammonium nitrate solution is prevented by adding a compound containing divalent sulfur linked to the carbon in an amount equivalent to 0.004-0.8% sulfur, to the ammonium nitrate-ammonia solution. Compounds in this group are ethyl sulfide, ethyl mercaptan, etc.

Bright Nickel Plating Solutions

Bright Nickel. U. S. Patent No. 2,211,535. H. Brown, assignor, by mesne assignments, to The Udylyte Corp. August 13, 1940. A method of bright nickel plating comprising deposition from a solution containing nickel sulfate, nickel chloride, and boric acid in the presence of an arsonic acid such as:

Phenylarsonic acid 1.0 -2.0 g./l.
Benzylarsonic acid 1.0 -2.0 "
n-Butylarsonic acid 1.0 -2.0 "
Allylarsonic acid 0.75-1.5 "

As an example of the plating solution:

Metallic nickel 75 g./l.
Chloride 15 "
Boric acid 35 "
Arsonic acid brightener Below 2 g./l.
Temp. = Room to boiling, preferably 50°C.

pH = 1.5-3.5, preferably 2.0-3.0
Current density = preferably 4.0-7.5 amps./sq. dm.

Auxiliary brighteners may be used for greater brightness where high ductility and maximum corrosion resistance are non-important. For example:

Zinc 0.25 g./l. optimum
Cadmium 0.4 " "
Selenium 0.15 " "
Tellurium 0.15 " "

Polishing Composition

Polishing Composition. U. S. Patent No. 2,214,263. F. A. Weike, assignor to McAleer Mfg. Co., Sept. 10, 1940. A polishing composition in the form of a hard firm cake for cleaning, polishing and coating lacquered surfaces with a protective coating of wax and containing essentially about 13% wax and plasticizer, 65% mineral spirits and 22% of an abrasive adsorbent.

Ex:
Carnauba wax 6.03%
Paraffin wax 5.14%
Paraffin oil 2.23%
Mineral spirits 64.20%
Finely divided diatomaceous earth 22.33%
Odorant 0.064%
Green dye 0.006%

Zinc Anodes

Zinc Anode. U. S. Patent No. 2,214,331. R. O. Hull, assignor to E. I. duPont de Nemours & Co., Sept. 10, 1940. The anode efficiency in cyanide zinc plating solutions is higher than the cathode efficiency and as a result the metal content of the solution rises. The anode efficiency is reduced according to the claims of this patent by the addition of calcium to the anode in amounts ranging from 0.05% to 5.0%, usually from 0.25% to 1.25%.

Galvanized Iron Sheet

Galvanized Iron Sheet. U. S. Patent No. 2,212,269-71. H. L. Kohler, assignor to A. A. Kramer. A galvanized sheet, the corrosion resistance of which is improved at the places where bending or forming has been effected by cleaning and applying to the outside an amalgam of zinc and mercury, or zinc, tin, lead and mercury, or tin, zinc and mercury at such places.

Centrifugal Blasting Machine

Blasting Machine. U. S. Patent No. 2,212,451. L. D. Peik, assignor to The American Foundry Equipment Co. August

20, 1940. A centrifugal machine for throwing abrasives at blasting velocities using an improved type of rotor.

Full Automatic Conveyor

Full Automatic Conveyor. U. S. Patent No. 2,214,262. V. W. Todd, assignor to Hanson-Van Winkle-Munning Co., Sept. 10, 1940. A machine for transferring articles through a plurality of tanks.

Buffing Wheel

Buffing Wheel. U. S. Patent No. 2,215,522. H. E. Hargy, Sr., Sept. 24, 1940. A folded disc wheel to hold large amounts of polishing compound.

Interesting Facts About Metals

The oldest iron mine in America is the Dickerson mine, on Mine Hill, west of Dover, N. Y. It was opened in 1700 and over a million pounds of ore have been taken from it. It is now owned by Rutgers University School of Mining.

Polonium, used in the manufacture of spark plugs for automobiles, is worth \$7,000,000 per ounce and is found in Poland, of which Mme. Curie, the great woman scientist, was a native.

The Greeks were the first people to strike coins of silver. They struck such coins as early as 869 B.C.

Gold is first mentioned in sacred scripture in Genesis 2-11. Gold is mentioned 300 times in the Bible. Silver is first mentioned in Genesis 23-15 and appears in the scriptures over 200 times.

In early days, both gold and silver were very plentiful. We read that when Rome was captured by Alaric, the Goth, he demanded as his tribute 5,000 pounds of gold, 2,000 pounds of silver and 2,000 pounds of pepper. Ancient records often tell of the use of pepper as money. Common black pepper was one of the earliest spices known and was as costly as silver.

In the very early days of Peru, gold and silver were very plentiful and it is said that in the great temple of the Sun, which was at Cuzco, the walls, cornices, statuary, plates and ornaments were all of gold and even the agricultural implements used in the garden were of gold and silver.

The monasteries in Anglo-Saxon times were the homes of expert craftsmen in all branches of artistic production, including especially goldsmiths and silversmiths. Every monk was expected to learn a handicraft and those of the goldsmith and silversmith were highly esteemed.

Charlemagne was buried in a coffin of solid gold, which was surrounded by a great number of candelabra of the same noble metal.

Fundamentals of Science Relating to Electroplating

Chapter 5

The general theory, dating back to Faraday himself, has been that an oxide film is formed on the metal which protects it from chemical attack. It is interesting to point out, however, that within the past year or so a new theory has been advanced which dismisses the need and in some cases even correlates the phenomenon of passivity with the electron arrangement in and around the metal atoms. Even here, in other words, our pet electrons are coming to the fore!

To summarize these properties of metals, it may be said that metal strength and the plastic properties are due to crystal structure as well as to the type of bonding involved. The electrical, thermal, thermo-electric, thermo-electric-magnetic and optical properties are closely associated with metals' exclusive feature—the free electrons, and are therefore, together with the above chemical properties, the fundamental criteria for metallicity. Substances possessing all the above properties, especially to an appreciable degree, are metals. Certain non-metallic substances may variously possess some, but never all, of the enumerated characteristics.

Appendix to Chapter 4

The periodic Table mentioned in the previous chapter is an arrangement of the known elements first devised by the Russian chemist Mendelejeff (pronounced Mendelayeff) which has permitted some of the most remarkable prophecies in chemistry. Originally, he arranged the elements known at the time in the order of their atomic weights (with a few exceptions) and found that at definite intervals, often at every eighth element, elements with similar prop-

This chapter concludes the discussion on the periodic arrangement of the elements. Acids, bases and salts are discussed. Ionization is also considered.

erties reoccurred; or working conversely, when he arranged the elements in vertical columns according to similarity of properties, he found that they were then horizontally arranged according to increasing atomic weight, with a few exceptions. We know now that if we use atomic number instead of atomic weight i.e. atomic structure instead of weight, these few exceptions also disappear. Occasionally, some blanks had to be left to get the elements in their proper positions, and in such cases the properties of the elements to be fitted into these blanks could be foretold, by reference to the properties of their neighbors, long before the elements themselves were discovered. These points are illustrated in the following popular scheme of the periodic system of the elements.

Omitting hydrogen, the elements directly under one another have similar properties, as lithium (Li), sodium (Na), potassium (K), cesium (Cs) and virginius (Vi). The elements in each of the vertical groups have the same valence, zero valence meaning inability to combine chemically so that Group O contains the so-called inert gases. Further, in most groups there are two subgroups, marked A and B, in which the elements are more related to each other than to the rest of the main group. Thus subgroup B in Group 1 contains copper (Cu), silver (Ag) and gold (Au), which electroplaters will recognize as being plated from very similar solutions; and subgroup B in Group 7 contains the four "halogen"

gases fluorine (F), chlorine (Cl), bromine (Br) and iodine (I) which have very similar properties. Group 1 has the most active elements that can form positive ions and Group 7 has the most active elements that can form negative ions. In between are the various gradations. The activity also decreases in going from the top to the bottom. Thus fluorine is more active than iodine in Group 7. Many other generalities and family traits can be stated, some of which will appear in later chemical discussions, and which are very useful guides, for example, in devising plating solutions. Elements numbered 85 and 87 were discovered only recently but their physical and chemical properties could be closely foretold from their positions in the table. Modifications of this table are often used to better emphasize certain properties, such as the table in the preceding chapter showing the degree of metallic properties of the elements. (See editorial pages of November 1940 issue).

5. Acids, Bases and Salts

The expression "Salt of the earth" has in reality more significance in it than slang, because therein lies a tale of the beginning of a new period in chemistry. When the chemists of ancient times took two of the original Greek "elements"—earth and water—and added one to the other, two new materials were formed: one, a solution of part of the earth, and the other, the remainder of the earth that was not dissolved. The solution part, which had a definite taste, was called a "salt" (we use a different definition today). Now when they applied a third Greek "element"—fire—to a "salt", the latter broke down and gave a volatile part which they called "spirit" or "corrosive water" and a non-volatile part. And so there came into being the concept of two opposite types of materials, which were later called, respectively, "acids" and "alkalies" (bases), and their combination gave "salts".

The next question quite naturally was something to the effect—"Why is an acid?" and the story of how this question was answered is the story of a good part of our chemical progress. The ancients knew that all acids had sour tastes and that they all neutralized alkalies. It seemed logical, then, that they possessed some common ingredient. They knew also that acids could be formed by burning sulfur, carbon, phosphorus and other materials and that in so doing, heat and light were liberated. They said, therefore, that acids were caused by the loss of something. A gentleman by the name of Stahl called this something "phlogiston".

Period	Group O	Group 1 A B	Group 2 A B	Group 3 A B	Group 4 A B	Group 5 A B	Group 6 A B	Group 7 A B	Group 8
I		1 H							
II	2 He	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	
III	10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	
IV	18 Ar	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe
		29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	27 Co
V	36 Kr	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru
		47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	45 Rh
VI	54 Xe	55 Cs	56 Ba	57-71 Rare Earths	72 Hf	73 Ta	74 W	75 Re	76 Os
		79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	77 Ir
VII	86 Rn	87 Vi	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 ?	78 Pt

Periodic arrangement of the elements into groups according to a popular scheme.

But then it was realized that these substances actually gained weight. A French scientist, Lavoisier, therefore suggested that instead of losing phlogiston in making acids, oxygen was gained. It was a fairly simple step after that to show that it was no oxygen that was the common ingredient in acids, but that actually all acids contained hydrogen. The progress we have made since then is to define the condition of the hydrogen which is present in every acid. We can best do this now by approaching the subject from a different angle.

It will be recalled that in discussing the atom, it was mentioned that most atoms could be made to either lose or gain electric charges (in the form of electrons) and that such electrically charged atoms were called *ions*. The process of forming ions is called *ionization* and a theory of ionization in solutions was first put forth by the celebrated Swedish chemist Arrhenius in 1887. Simply put, his theory, which is universally accepted today with some modifications, said that certain substances when dissolved in certain solvents (of which water is the most important) were at least to some extent *dissociated* (i.e. broken down) into positive and negative ions, corresponding to their constituents. Since the original substances and the final solution were as a whole electrically neutral, the total number of positive charges on the positive ions was the same as the total number of negative charges on the negative ions. Only such solutions can conduct electricity and the substances referred to, that produce conducting solutions, are called *electrolytes*. (Very often the solutions containing these substances are incorrectly called electrolytes.)

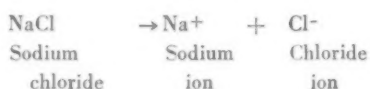
Note that not only must we have electrolytes to get conduction, but we must also have the proper solvent. Thus pure hydrogen chloride dissolved in water (known as hydrochloric acid) is a good conductor, but not if it is dissolved in benzene. We shall have more to say about the method of conduction and the types of electrolytes later. This subject is important to us at this moment because all acids, bases and salts are electrolytes and vice versa. Thus sugars and alcohols do not give conducting solutions.

A few other points about ionization must be mentioned. First of all, it was said in an earlier chapter that the valence of an element represented the number of unit charges of electricity on the ion of that element. So in solution a calcium ion (Ca^{++}) has twice the charge of a sodium ion (Na^{+}) and can neutralize two chlorine ions (Cl^{-}) because each of the latter has only one unit charge.

Secondly, electrolytes do not necessarily break up completely into ions; in other words, there exists a degree of ionization for each electrolyte. While there is even today a little question as to the exact mechanism by which varying degrees of ionization are brought about, for our purposes we may consider that often only a certain percentage of the molecules of the substance dissolved do ionize, the remainder being un-ionized molecules. Where the percentage ionization is high (practically 100%) the

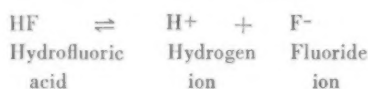
substances are called *strong electrolytes* and the degree of ionization is essentially the same regardless of the concentration of the electrolyte in the water, although the *activity* of the ions becomes hampered the more there are in a given volume, so that the net effect may be the same as though ionization were not 100%. Where the degree of ionization tends to be small, the substances are called *weak electrolytes* and the percentage ionization increases as the solution becomes more and more dilute. It is important to realize that solubility has nothing to do with degree of ionization. Thus silver chloride is hardly soluble in water, but the minute amount that does dissolve is highly ionized.

It is common in chemistry to represent ionization by the following reaction:



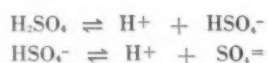
This means that, in water for example, un-ionized sodium chloride is completely dissociated into sodium ions and chloride ions. Note that the positive (+) charges balance the negative (−) charges.

Consider now the following:



Not only is the un-ionized hydrofluoric acid dissociated into hydrogen and fluoride ions (indicated by the arrow \rightarrow) but the latter are also combining to form un-ionized hydrofluoric acid (indicated by the arrow \leftarrow). This "tug-of-war" is going on continually but in any one solution there is always a definite percentage of un-ionized molecules and ionized molecules. It is just as though it were a continual dance; a certain number of couples dancing and a certain number each of uncoupled ladies and gents walking around seeking partners. Let us assume that on the average, as some couples get tired and separate, an equal number of couples is formed by the separate partners so that there are always the same number of couples dancing and the same number of individuals walking around. This, in chemistry, is called *equilibrium* (at dances the word has a quite different meaning).

Besides as in the above reactions, ionization may take place in several stages. For example:



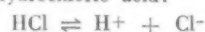
This means that sulfuric acid forms its ultimate ions hydrogen and sulfate only by going through the intermediate HSO_4^{-} ions, which also exist in solution with the H^{+} and SO_4^{2-} .

We must remember that ions do not have the same properties as their parent atoms, since their electrical make-up is different, so that the properties of chlorine gas, for example, are not the same as those of the

chloride ion (Cl^{-}), and one should not expect to easily form sodium metal and chlorine gas from sodium chloride, just because the ions are easily formed in solution. Ions and atoms are not the same, any more than compounds and mixtures are the same. (See previous Chapter II, Oct., 1940 issue). Somewhat along similar lines, it should be stressed that the properties of substances (salts, acids, and bases) to be described refer to their properties *as ions in solution*. This may be quite different from their action when dry. Sodium metal floats on sulfuric acid that is free from water but it explodes in a sulfuric acid solution. Ammonium carbonate and cupric nitrate in solution form merely ammonium nitrate and copper carbonate. If they are heated together dry, there are formed a mixture of oxides of copper, oxides of nitrogen, carbon dioxide, water and maybe other things.

We had temporarily concluded our discussion of acids above by stating that an acid was a substance containing hydrogen in a certain condition. After what has been said about ions we may now more fully define an *acid*, for our purposes, as a substance capable of forming hydrogen ions in aqueous solutions. To illustrate this, the ionization reactions of some common acids are given here:

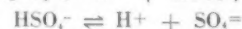
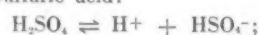
Hydrochloric acid:



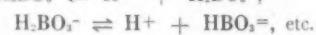
Nitric acid:



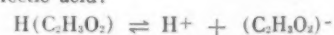
Sulfuric acid:



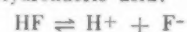
Boric acid:



Acetic acid:



Hydrofluoric acid:



Notice that in every case hydrogen ions (H^{+}) are formed. Notice too that in acetic acid, the acetate radical ($\text{C}_2\text{H}_3\text{O}_2^{-}$) contains hydrogen but this hydrogen does not form ions. Similarly, sugar ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) and methane (CH_4) contain hydrogen, but in solution *no hydrogen ions* are formed so these substances are *not* acids and do not have the properties of acids.

It is obvious from the above, too, that the only other part of an acid is the atom or radical of negative valence. This negative portion, in general, contains a non-metallic element like sulfur, chlorine or nitrogen. The acid consists of either such an element directly combined with hydrogen to form *binary acids* like hydrogen sulfide (H_2S) and hydrochloric acid (HCl) or the oxide of such an element combined with water to form the *oxy-acids* such as sulfuric (H_2SO_4) acid made up of sulfur trioxide and water, nitric acid (HNO_3) made of nitrogen pentoxide and water, etc. Such oxides which, with water, forms acids, are called the *anhydrides* of their respective acids.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Improved Sawdusts

Frank Miller & Sons, 2242 West 58th Street, Chicago, Ill., have sawdusts available that are claimed to offer advantages for metal drying purposes and for finishing of metal due to their high absorbing qualities. The sawdusts are made from 100% kiln dried hardwood maple, which is recognized as one of the purest woods obtainable for the purpose, due to absence of tannic acid and resins which cause staining. The absence of resin obviates possibilities of the work being spotted or having sticky substances fastened to them, which conditions are frequently experienced with the use of soft woods or mixed sawdusts containing resins or acids.

The sawdusts are available in various uniform mesh sizes so that the user has a variety from which to select, in order to insure the proper mesh for the work to be performed.

The company has facilities available to grade the sawdust to the individual's requirements, in the event the standard grades do not fit in with any special requirement.

Another feature reported for the improved sawdust is that the dust has been removed. Old type sawdusts contained dust which would arise as a cloud whenever the sawdust was disturbed, settling upon the work and machinery in the room, and being a nuisance to the workmen.

Further information on sawdusts will be gladly furnished by the manufacturer upon request.

Aluminum Cleaners

Puro Chemicals, Inc., 1643 St. Clair Ave., Cleveland, Ohio, have announced the development of three special cleaners for cleaning aluminum, called respectively, "Puro Special Aluminum Cleaners Nos. 1, 2 and 40." These cleaners are recommended for use in still tank and concentration of from 6 to 8 ounces per gallon at temperatures from 180°-190° F.

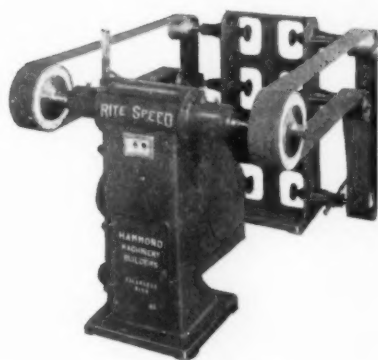
It is stated that these cleaners eliminate smudges and finger marks, and also the wiping of polished aluminum parts. Cleaners Nos. 1 and 2 are stated to have proven satisfactory for cleaning aluminum reflectors, which job previously required wiping.

New Abrasive Belt Polisher

The Hammond Machinery Builders, Inc., have just brought out an abrasive belt stand to be used in conjunction with polishing and buffing lathes.

The illustration shows this stand in use

The Post Scripts Section usually facing this page is now located opposite inside back cover.



Abrasive belt polisher.

with the company's "Model 7-CH Rite-Speed Lathe".

The abrasive stand and lathe shown, use 5" belts, but wider or narrower belts can be furnished to suit the application. Proper tension of the belt is maintained by an adjustable tightener pulley and the belts can be quickly removed and replaced.

It is stated that for many classes of work, these abrasive belts show a definite economy over set-up wheels.

For particulars write Hammond Machinery Builders, Inc., 1601 Douglas Ave., Kalamazoo, Mich.

Lead Anode for Chromium Plating

Republic Lead Equipment Co., 7928 Jones Rd., Cleveland, Ohio, have announced a new development on their "Multi-Edge" lead anode for chromium plating, which was first introduced in 1936.

The anode is now available in new and improved design with 10 corners instead of 8. It is stated that the addition of 2 more corners gives this anode greater efficiency and throwing power. The ribs on the new anode are beveled, thus giving a higher degree of strength and rigidity, and a reduction in the tendency to curl.

The anode is made by the extrusion process, which is claimed to give a firm and dense texture to the lead. The anodes measure 1/2" in thickness by 3" wide, and can be

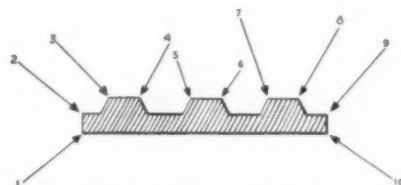


Diagram of lead anode showing 10 corners or edges available.



Front view of "Multi-edge" anode.

furnished in any length. Each anode is stenciled for height of solution level, and can be supplied with knife edge or flat hooks, shaped to the user's specifications. The hooks are burned in by the homogeneous lead process, which is stated to assure positive electrical contact and conductivity.

The anode is distributed by supply houses throughout the U. S.

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Use it on any kind of a wheel, soft, hard, medium. Results will speak more eloquently than anything we could say.

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Samples of Compound or Cement sent on request.

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Sodium Metasilicate

The Cowles Detergent Co., 7016 Euclid Ave., Cleveland, Ohio, have announced a change in the name of their pentahydrate sodium metasilicate from "Escomet" to "Cry-stamet". Only the name is changed; the material, price, packaging, etc., remain as before. The change in name was made to enable easier remembering and to make it more descriptive of the crystalline, white metasilicate which carries the normal 42% water of crystallization. The material is available in two grinds at the same price.

Barrel and Drum Tipper

Lewis-Shepard Sales Corp., 245 Walnut St., Watertown (Boston), Mass., have developed a new device for the handling of barrels and drums. The tipper consists of a strong handle with a pronged collar which is adjustable. This adjustable collar allows the tipper to fit all types of drums and large or small-bilged barrels.



Handling a barrel with new drum tipper.

Its job is to facilitate the tipping of barrels from a horizontal to a vertical position, or the reverse. The long handle increases the leverage so that much less effort is required to handle barrels or drums than in the ordinary manner.

Metal Fume Respirator

Mine Safety Appliances Co., Braddock,



Metal fume respirator.

Thomas and Meade Sts., Pittsburgh, Pa., have developed a new respirator for protection against fumes of metals, such as generated when burning, pouring or molding lead, cadmium, zinc or other volatile metals.

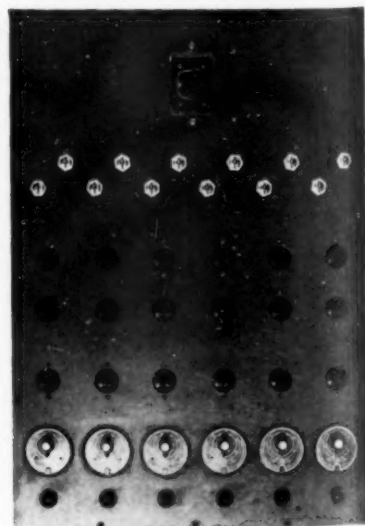
The respirator is approved by the U. S. Bureau of Mines, and is said to provide complete working freedom, permitting the use of goggles or headgear of any kind without interference.

Constructional features claimed are: filters of unique design with high filtering efficiency; large filter area; aluminum filter containers to keep out grease and dirt; all-rubber facepiece which fits snugly; foolproof U. S. Army-type exhalation valve.

Timing Control for Tumbling Barrels

R. W. Cramer Co., Inc., Centerbrook, Conn., manufacturers of electrical timing devices, have designed timing controls for tumbling barrels, used particularly for finishing of plastic parts.

It is stated that without proper timing control, breakage of plastic parts has been



Timing control for tumbling barrels for burnishing plastics.

experienced while being tumbled to remove the flash, and it has been found that there exists a very decided and critical length of time the parts should be tumbled, and when this critical period was exceeded, the main piece of molding would start to check, crack and break off.

After determining the correct burnishing time, the use of the timing device is stated to assure elimination of difficulties from over-tumbling. A large panel board contains the time controlling switches for the tumbling barrels to be controlled, and each timer is so designed as to be set when the respective barrel is put into operation, and automatically throws off and stops the operation when that barrel reaches the critical period.

The panel or control board is so designed as to enable the operator of any tumbling barrel, to "plug in" on the "not busy" timer when he starts operation.

Aluminum Solder

Colonial Alloys Co., E. Somerset, Trenton Ave. & Martha St., Philadelphia, Pa., have announced the development of a new alloy called "Colaweld 'T' Rod", for the soldering of aluminum and its alloys without the use of a flux. The use of the new solder is said to obviate the necessity of roughening the metal surfaces, and the absence of flux is stated to make the soldering operation more pleasant and less toxic to the worker, and to also eliminate progressive corrosion.

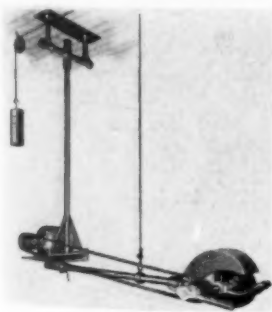
The method of application is much like soldering. In inaccessible places, such as under lap joints, pre-tinning these surfaces with the solder is recommended, followed by sweating the tinned surfaces together.

On other types of joints, however, the rod is simply rubbed over the heated metal until it melts or when applied with a hot iron, the iron is moved back and forth over the metal, spreading the molten metal until it wets the surface. The alloy can also be used for filling cracks and holes.

Some of the features claimed for this material are: high strength bond and high tensile strength; unusual corrosion resistance; easy machining and electroplating. The alloy together with the company's liquid flux, is also recommended as a joining material for 18-8 stainless steel, copper alloys (brass, Monel), steel, galvanized iron, etc.

Grinding and Polishing Machine

Jefferson Machine Tool Co., Fourth, Cutter and Sweeney Sts., Cincinnati, Ohio, in a recent release have described their No. 101



Wide swing grinding and polishing machine.

swing frame grinding and polishing machine, which is recommended for the grinding, polishing and buffing of large pieces. It is a full universal type of machine, which can be swung forward and backward, up and down, right and left, and at any degree of angle or twist at the spindle head.

The machine is bolted to the ceiling and no aligning or countershafting is required. The machine is said to be suitable for grinding or cleaning rough castings of any kind or shape, and is particularly recommended for preparing metals previous to enameling, finishing, etc. It is also utilized for grinding or polishing sheets, tubing, bars and shapes too large for the usual standard floor lathes. Scratch wheel brushes can be used for cleaning castings. Counter balancing makes the head light and easy to handle.

Metal Plating Plastic Materials

Although plastic materials do not conduct electricity, they can now be plated by a simple and highly efficient process. A firmly adherent and highly conductive

bond coat is formed on the surface of the plastic and the metal is electroplated thereon. This bond coat may be applied to the entire surface or any desired portion thereof. Due to the permanent adhesion between the metal and the plastic an extremely thin deposit of metal is sufficient to withstand buffing, shock, wear and variations of temperature.

In designing fixtures of all kinds, the trend is definitely toward bright chromium and rich gold finishes. Complicated shapes which could not be economically made of metal, can be molded of plastic and plated to obtain the desired effect. By plating the metal on specified regions of the plastic material, attractive designs and contrasts can be obtained between the attractive plastic colors and the bright metal finishes.

This method is being used extensively in plating novelties, dress ornaments, bottle caps, knife handles, and among the most recent applications are found control knobs, electrical and radio parts,

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Enthone Acid Addition Agent is a unique surface tension depressant used in hot or cold sulfuric or muriatic acid pickles. Extensive laboratory tests and many industrial users have shown that with the use of ENTHONE AAA the following results are obtained:

- ★ **FASTER PICKLING**—the acid rapidly penetrates under rust and scale, thus lifting them off!
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- ★ **SAVES ACID**—Drag-out is materially reduced and acid is saved by inhibiting action!
- ★ **OVERCOMES WATER-BREAK IN PICKLING**—Due to poor alkaline cleaning or soap in the alkaline cleaner, water-breaks appear on acid dipping before plating. The use of ENTHONE AAA in the acid literally makes the acid a cleaner and overcomes peeling due to faulty cleaning.
- ★ **FASTER STRIPPING OF HEAVY CHROMIUM**—The use of ENTHONE AAA in muriatic acid greatly increases the stripping action on faulty hard chromium and eliminates attack on steel die.
- ★ **FOR STRIPPING ZINC OR CADMIUM FROM PLATING CYLINDERS**—ENTHONE AAA used in acid for stripping zinc or cadmium from plating cylinders will speed the stripping. The acid will penetrate every recess to remove metal causing disintegration of the cylinder. Attack on steel tie-rods is eliminated.

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Mutual Chemical Co. of America

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SALT SPRAY CORROSION TEST EQUIPMENT

DESIGNED TO:—Determine the corrosion resisting qualities of electroplated or coated metal, Alloys, Metal Parts, Lacquered or Painted samples, etc.

This equipment combines all the necessary features so that salt spray tests can be conducted to specifications at controlled temperatures from 65 to 95 Deg. Fah. Tests to conform with Army, Navy & Aeronautical specifications, as outlined in Bulletin AN-QQ-S-91-5 dated Dec. 1938 can accurately be conducted.

Testing cabinets are made in four sizes, and can be supplied without the temperature control feature if desired.

(Cabinets are completely covered on inside with 1/8" thick rubber.)

Write for new descriptive literature.

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rollers, cams, gears and other industrial parts.

In general it is found that complicated small knobs, push buttons and other parts can be molded of plastic for a fraction of the cost of making the same part in metal. This is especially true of heavy die castings and screw machine parts. Of course, where plating is contemplated, inexpensive plastic materials can be utilized. As a result, the total cost of a chromium plated plastic part is less than what a similar unit would cost if made of metal and chromium plated.

This plated plastic weighs much less than its metal equivalent and has a considerably greater resistance to denting, bending and deforming caused by impact and dropping. As a result, these light weight plated plastic sections having the appearance of highly polished metal are used without the customary denting which is found when thin metal sections are employed.

By plating certain parts of the surface of a plastic material, electrical units combining the properties of a conductor and insulator in one integral part are possible. As the metal and the insulator material are firmly bonded together, there is no possibility of the metal loosening up to change the capacity of the unit, and vibration and rattling are completely eliminated.

As the surface hardness of plastic materials is not sufficient for many industrial applications, it has been found advantageous to deposit hard chromium at the points of wear, thereby increasing the life of the part and in some cases making the use of a light-weight plastic possible where it would otherwise be unsuited. This deposit also resists attack due to oils, moisture and other fluids. This metal deposit also removes any static electricity which might form on the surface of the plastic, which would be objectionable for many reasons, such as collecting dust, electrical and interference, etc. Gears, rollers, valve parts, indicators and other parts made of laminated or molded plastic materials are being plated to take advantage of one or more of the above-mentioned properties of the metal deposited.

Methods and equipment have been devised and perfected for bonding, plating and finishing all types of plastic productions. In all these operations small parts can be tumbled by the thousands. For larger pieces, racking and spraying methods have been designed to reduce handling to a minimum, thereby assuring maximum efficiency in output, materials and labor.

The Metaplast Corporation, which has worked out and controls this process for plating plastic material, maintains a laboratory and pilot plant in New York City, to help determine whether it is advantageous to plate plastics or replace metals with plated plastic materials. The corporation works under the following patents: Stencil, U. S. Patent No. 2,200,314, May 14, 1940; U. S. Patent No. 2,213,646, Sept. 10, 1940.

Manufacturers' Literature

Cleaning of Metals. Oakite Products, Inc., 22 Thames St., New York, have recently issued a 32-page booklet entitled, "Cleaning of Metals before Electroplating", which outlines formulae and methods for cleaning many different metals and alloys. The book should be of value to works managers, production managers, plating supervisors and contract finishing shops or to all who desire a handy compact guide on the most recent developments, materials and methods designed for effective cleaning. The cleaning of specific metals and alloys is discussed, as well as other subjects, such as tumbling, burnishing, etching, pickling, tank installations, etc.

Copies of this book are available on request to the company.

Electroplating. The electroplating Division of E. I. duPont de Nemours & Co., Inc., Wilmington, Del., has recently issued a 16-page booklet describing the company's chemicals, processes and materials for electroplating. Included are cadmium, zinc, tin, copper, nickel, chromium, gold and silver salts and plating processes, as well as the company's proprietary solutions for producing black finishes, brass plating and high speed copper plating.

Handling Equipment. A circular No. 60-201 of Lewis-Shepard Sales Corp., 245 Walnut St., Watertown (Boston), Mass., describes and illustrates equipment for handling drums and acid carboys. The equipment described includes drum drain stand, barrel and drum tipper, carboy pourer, carboy handling truck and various other trucks.

Heavy Chemicals. A 6-page folder recently issued by the Cowles Detergent Co., 7016 Euclid Ave., Cleveland, Ohio, describes the company's various sodium silicates. Discussed are commercial anhydrous sodium metasilicate, pentahydrate sodium metasilicate and technically anhydrous sodium orthosilicate, called respectively, "Drymet", "Cry-stamet" and "Dryorth".

Pyrometers. Catalog No. 1101 F of C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y., describes and illustrates the company's electric thermometers and pyrometers.

Rotary Blast Barrels. Bulletin 213 issued by Pangborn Corp., Hagerstown, Md., in 26 pages describes and illustrates barrel equipment for shot blasting of work. Phantom drawings are used to illustrate the operation and construction of the equipment. Condensed data on barrels for shot blasting are given.

Swing Frame Grinding and Polishing Machine. Swing frame grinding and polishing machines for wheels up to 14" in diameter are described in a recent bulletin issued by Jefferson Machine Tool Co., 4th, Cutter & Sweeney Sts., Cincinnati, Ohio. The swing lathe is recommended for foundries, plating plants and factories where considerable



One for the BOOK!

Here's a report from a metal finishing plant that will have a prominent place in the Wyandotte Record Book:

The plant is using Wyandotte C.S.R. cleaner for cleaning polished steel stampings prior to bright nickel plating directly on the steel.

Here's the report: No cyanide dip or copper strike in the line. Parts are assembled in jig, and after bright nickel plating, followed by chrome plating, they are spot-welded with absolutely no lifting of the plate.

Your Wyandotte Representative will be glad to show you what Wyandotte C.S.R. — or any Wyandotte Metal Cleaning Compound — can do for you. Write us.

Wyandotte
THE J.B. FORD SALES CO. SERVICE REPRESENTATIVES IN 88 CITIES
WYANDOTTE MICH.

grinding, polishing and buffing on large pieces is necessary.

Correspondence

Study of Sodium Stannate Tin Plating Solution

TIN RESEARCH INSTITUTE
controlled by the
INTERNATIONAL TIN RESEARCH &
DEVELOPMENT COUNCIL

Fraser Road,
Greenford,
Middlesex,
England

18th November, 1940.

Dr. Walter R. Meyer, Editor,
METAL FINISHING,
116 John Street,
New York, U. S. A.

Dear Sir:

I was interested to read on Page 374 of your July issue an abstract of the paper by Mr. F. Bauch on this subject. This abstract consists of a reproduction of most of the author's conclusions, but in one or two respects these conclusions seem to be misleading, and not entirely in agreement with the rest of the paper.

Under heading No. 3, there is an unfortunate misprint in the fifth line, where the word "stannate" has been used instead



Cowles METAL CLEANERS

ARE MEETING THE RIGID DEMANDS OF INDUSTRY

Cowles Anhydrous Metal Cleaners are proving to be outstanding on the toughest cleaning jobs. They clean quickly and rinse easily and thoroughly. Cowles Cleaners contain no "trick" ingredients that effect subsequent operations.

If you have a cleaning problem, why not put it up to us. A Cowles Service Man will gladly help in solving your problems and demonstrate the advantages of Cowles Anhydrous Cleaners. The line is complete, 12 outstanding different cleaners. Immediate delivery can be made of any cleaner in the line.

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 Eaton-Clark Co., Detroit • James H. Rhodes & Co., Long Island City and Chicago • Mau-Sherwood Supply Co., Cleveland
 Apex Soap & Sanitary Corp., McKees Rocks, Pa.

COWLES CLEANERS

THE COWLES DETERGENT CO.
 7016 EUCLID AVENUE • CLEVELAND, OHIO

of "stannite". This alters the whole meaning of the remarks.

Mr. Bauch's suggestion that a hydroxide film (presumably stannous hydroxide) forms on the anodes when the current is off, and is removed by application of a high current density, seems to be an unnecessary complication. Moreover, it is not supported by any evidence in the paper. It is not impossible that such a film is present, but the appearance of the anodes is merely that of a clean tin surface. The generally accepted theory is that the initial application of a high current density produces a stannic oxide film on the tin surface (hence the greenish yellow color), and that this film is lost when the current is switched off.

This seems to fit the facts quite well, and one hesitates to accept Mr. Bauch's new theory without conclusive proof, particularly as it makes the operation of the bath much more difficult to understand.

The suggestion that "a sodium stannate

bath may cause considerable difficulties as the bath can only be operated over a narrow range" is very misleading. Actually, the range of conditions over which the bath gives good results, is reasonably wide, as Mr. Bauch states in his introduction to the paper.

The range is, for example, nothing like as narrow as that needed for working a chromium plating solution. Also in his paper Mr. Bauch makes it clear that the sodium stannate bath is very widely used for both small installations and for large automatic plating conveyors, and in his own firm they employ a plating machine using some 9,000 gallons of solution.

Yours faithfully,

Sydney Baier,
 Tin Research Institute.

Editor's note—The editor regrets the use of the word "stannate" instead of the word "stannite". The conclusions published in the abstract of Mr. Bauch's paper were taken from the paper itself and were not

the conclusions of the abstractor. We have, therefore, referred Mr. Baier's letter to Mr. Bauch, whose reply follows.

A Reply From Mr. Bauch

FRIGIDAIRE DIVISION
 GENERAL MOTORS CORPORATION

Dayton, Ohio, U. S. A.

December 22nd, 1940.

Editor,
 METAL FINISHING,
 116 John St.,
 New York, N. Y.
 Dear Dr. Meyer:

This is an answer to the letter from Mr. Sydney Baier from the Tin Research Institute, and I am submitting the following comments:

Fairly reasonable proof of the presence of a film, formed on a tin anode, when the anode is immersed in a sodium stannate, sodium hydroxide solution, with the current off, may be established by the following tests:

1. When a polished and cleaned anode is immersed quickly, with the potential adjusted well below the previously established critical value, into the solution, there will be no surge of the current, the current will never rise to the critical current density and the green film may form on the anode later.

2. When the same experiment is made with an anode previously used and immersed but when this anode is not rinsed and then immersed into the solution, there will be a surge of current and the anode will continue to dissolve as stannite.

3. When a previously used anode, as in Test No. 2, is rinsed well before it is immersed into the solution, the anode will show similar characteristics as the anode in Test No. 1.

When the current is lowered sufficiently the anode may not get coated with the green film, but no trace of stannite will be detectable and the cathode plated will have a smooth and mat white coating.

From the experiments conducted, the coating seems to form very fast, and seems to be either soluble in water or loosely adherent, so that it may be removed upon rinsing. Activation in the sodium stannate solution does not seem to produce the same results as when rinsed in cold or hot water.

I regret that I am not at the present time able to furnish a better proof of this film, but as this film seems to be very thin, it might be extremely difficult to establish a positive proof.

My reference to the narrow range of possible operation of the bath needs the following comment:

The bath may be operated over a seemingly wide range of conditions of the solution, but unless the balance of the solution is maintained, the characteristics of the solution change and no uniform results are obtainable. This is a very important characteristic for plating conveyors, and when plating to certain specifications. The theoretical as well as the practical balance of the solution are obtained however at a very definite point only.

When using this solution, it will be

found that it is comparatively simple to obtain a high cathode efficiency, but that in order to obtain a high anode efficiency, the anode current must be below the critical current density. This may be a source of some difficulties, especially with a changing cathode area or when plating hollow ware, where the maximum anode area as well as volume of solution are limited. As a rule, however, the slight deficiency in the anode efficiency may be compensated by an addition of sodium stannate. Theoretically this should cause gradual increase in free causticity of the solution, but due to atmospheric breakdown of the sodium hydroxide, this very seldom happens and in most cases it might even be necessary to add sodium hydroxide. From this standpoint many other solutions have a wider range, but there should be no serious difficulty in the successful operation of the sodium stannate bath on a commercial base.

Very truly yours,

Frederick Bauch,
Mfg. Research Laboratory.
FRIGIDAIRE DIVISION
Plant No. 2.

New Books

Powder Metallurgy: A Review of Its Literature. By Clark B. Carpenter. Quarterly of the Colorado School of Mines, Golden, Colo. Vol. XXXV, No. 4. October, 1940. Size 6" x 9"; 40 pages. Price 50c per copy. To obtain a copy, write to the Colorado School of Mines.

The literature of this new and increasingly important field has been covered thoroughly by Prof. Carpenter, in a correlated abstract. Methods of pulverizing metals, the physical characteristics of metal powders, treatment of metal powders and various general aspects of powder metallurgy are discussed.

The excellent correlation of the many references should make this book extremely valuable to anyone interested in powder metallurgy.

Handbook for Chemical Patents. By Edward Thomas. Published by Chemical Publishing Co., Inc., New York, N. Y. Price \$4.00.

This book has been written by a leading chemical patent attorney and one-time assistant examiner in the United States Patent Office.

It is interesting to note that although only 15% of all the patents are chemical patents, that 15% provide now over half of all patent litigation, apparently because of the difficulties inherent in chemical inventions as a result of poorly prepared patents.

The book is written in a simple manner with the discussion well classified, and in addition numerous case references are given to substantiate or amplify the points mentioned. The book discusses the value of patenting methods, patenting and drawing up of claims and patents, infringement, interferences, suits, etc. Be-

HARSHAW ANODES

More and more, skilful platers throughout the country are specifying Harshaw anodes . . . What better proof of superior performance is necessary?

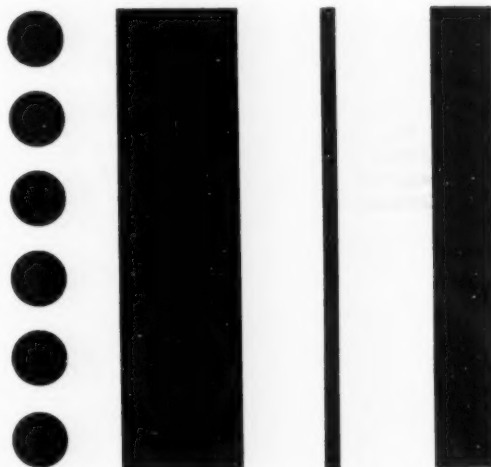
THE HARSHAW CHEMICAL CO.

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S-310 CLEAR RUST INHIBITIVE

S-310 is a clear, pale liquid which can be reduced 150-200%. This solution can be applied to bright metal surfaces by dip or spray and gives a remarkably hard, tough and adhesive film of pronounced resistance to rust or tarnish.

S-310 is now used by many manufacturers of hand tools, e.g., hatchets, shears, pliers, axes, auto wrenches, etc.; for hardware of the better grade; for the bright metal surfaces of machine tools.

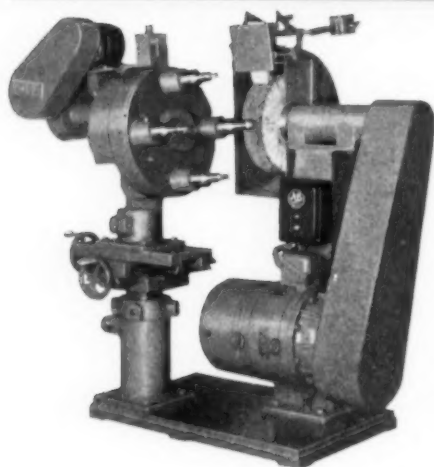
S-310 is indicated wherever a thin, hard, non-greasy film that resists rust in transit and storage is desired.

We welcome inquiries as to its applicability to your specific problem.

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Another "Acme" Combination Unit for Polishing and Buffing!



ACME
SEMI-AUTOMATIC
AND LATHE
COMBINATION
UNIT

**SEND
SAMPLE
for
FREE
Production
Estimate**

It is easy to understand how Acme Automatics speed up production when you stop to consider that the 4-spindle machine illustrated above, for polishing and buffing cylindrical parts, has an indexing range up to 80° indexings per hour, and a still greater speed when equipped with an 8-spindle head.

To meet the demands of present-day production, not only as to speed but also as to low production costs, Acmes are built in a great variety of machine arrangements of universal application, each so designed as to perform its particular job most efficiently. If you have a polishing or buffing problem, we shall be glad to submit suggestions as to how it can be solved.

Acme Manufacturing Co.
1642 HOWARD ST. • DETROIT, MICH.
Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

cause of the intimate discussion of chemical patent problems, this book should be of interest to all those engaged in chemical industries, including electroplating, both for the individual worker and the company executive.

Non-Ferrous Foundry Practice. By J. Laing and R. T. Rolfe. Published by D. Van Nostrand Co., Inc., New York, N. Y. Size 6" x 9"; 324 pages. Price \$6.00.

This book is a recent addition to the rather scant literature on non-ferrous foundry practice. The book presupposes a knowledge of elementary metallurgy, but, however, the various chapters discuss the constitution, and in some cases, structure of various non-ferrous alloys. This discussion should better enable the foundryman to select and handle the various alloys. Chapters are: Non-Ferrous Moulding Sands; Non-Ferrous Melting Furnaces; Bronzes; Copper and Straight Brasses; High-Tensile Brasses-Manganese-

Bronze; Aluminum-Bronze; Silicon-Bronzes and Brasses; Nickel-Silver, German Silver, White Brass, Nickeline, Etc.; Copper-Nickel Alloys; Aluminum Alloys; Magnesium Alloys.

Numerous excellent photomicrographs are used throughout the text to illustrate structure, and many drawings illustrate gating and the like.

Industrial Electrochemistry. Second Edition. By C. L. Mantell. Published by McGraw-Hill Book Co., Inc., New York, N. Y. Size 9" x 6"; 629 pages. Price \$5.50.

This valuable book has been brought up-to-date and enlarged in its second edition. All important electrochemical processes are covered, including, electroplating, electroforming, electrowinning and electrowinning of metals, electrolysis of alkali halides, the production of metals from fused salts, and the evolution of hydrogen and oxygen on a commercial scale.

Plant practices are given considerable attention and a large number of illustrations are included. One entire section is devoted to electrothermics. There is a full discussion of the electrochemistry of gases, vacuum tubes and electronics, nitrogen fixation, the preparation of ozone and Cottrell precipitation. Finally a section deals with the economic aspects of materials for the construction of electrochemical cells, furnaces and plants.

For engineers, chemists and plant men desiring a comprehensive treatment of industrial electrochemistry.

The Merck Index. Fifth Edition. Compiled and published by Merck & Company, Inc., Rahway, N. J. Size 9 1/4" x 6 1/4"; 1060 pages. Price \$3.00.

This encyclopedia of chemicals and drugs represents the most extensive compilation of this authoritative reference work that has been undertaken since the first edition appeared in 1889.

The steady progress of chemistry and its allied sciences has produced an unusual array of authentic scientific data on the physical, chemical and medicinal properties, as well as the various uses of chemicals and drugs. In the new edition of *The Merck Index*—comprising nearly twice the number of pages of the previous edition—there will be found 5,900 descriptions of individual substances; 4,500 chemical, clinico-chemical reactions, tests and reagents by the author's name; formulae for preparation of culture media, fixatives and staining solutions; useful tables; antidotes for poisons; literature references and other dependable information.

The Merck Index presents several features to which reference is seldom made in chemical reference works such as information for the pharmacist, physician, dentist and veterinarian. For this reason the book should be of value to research workers who desire to establish prior information on the subject which they are investigating.

Materials Handbook. By George S. Brady. Published by McGraw-Hill Book Co., Inc., New York, N. Y. Fourth Edition. Size 6" x 9"; 563 pages. Price \$5.00.

This is an encyclopedia arranged alphabetically of various chemicals, alloys, natural and commercial products that may be met with by the purchasing executive or the product engineer.

The descriptions are short, but usually are sufficiently informative to enable the reader to have a general idea of the product concerned. In many cases, names of proprietary products of various companies are given.

The appendix includes numerous tables, physical constants, and physical data that may be required by the purchasing executive.

Industrial Dermatitis. Fifth Edition. August 1940. Prepared by The Milburn Co., Detroit, Mich. Size 5 1/2" x 9"; 20 pages. Copy can be received, free of charge, by writing The Milburn Co. under company letter-head.

This booklet describes the various causes and means of prevention against

industrial skin diseases and enumerates 10 different kinds of creams and ointments for specific applications. Included is a scientific study of skin structure and composition, and the underlying principles of skin injury in relation to industrial dermatitis.

Numerous photographs illustrate typical eruptions and fitting micrographs illustrate the effects of various chemicals on protected and unprotected skin.

Technical Literature

Fabrication of Monel, Nickel and Inconel Seamless Pipe and Tubing. Bulletin T-17, October, 1940. Development and Research Div., The International Nickel Co., Inc., 67 Wall St., New York.

Engineering Properties of Monel. Bulletin T-5. Revised as of September 1940. Development and Research Div., The International Nickel Co., Inc., 67 Wall St., New York.

Ammonia in Metal Treating. 1940. Describes and illustrates case hardening, toughening and welding processes. Applications of ammonia and its properties are described. Published by The Mathieson Alkali Works (Inc.), 60 E. 42nd St., New York.

Practice in Machining Zinc Alloy Die Castings. This is the second and greatly enlarged edition; contains many new photographs of practical commercial fixtures which illustrate the ingenuity of tool designers. Discussed are drilling, tapping, threading, facing, broaching, shaving, grinding, polishing, burnishing, tumbling, buffing, sawing, spinning, etc. The New Jersey Zinc Co., 160 Front St., New York.

Associations and Societies

American Electroplaters' Society

**Plan to Attend Boston A.E.S.
Convention, June 9th-12th**

Baltimore-Washington Branch

The branch will hold its annual meeting on Saturday, February 8, 1941 at the Hotel Continental, near Union Station, Washington, D. C.

The educational session will start at 2:30 P.M. with the following authors and subjects for discussion:

E. J. Roehl, International Nickel Co., Inc., Bayonne, N. J., "The Adhesion of Nickel Deposits".

Urban A. Mullin, Wright Aeronautical Corp., Paterson, N. J., "The Use of Electrodeposition in the Airplane Industry".

Derick S. Hartshorn, Jr., Enthone Co., New Haven, Conn., "The Use of Wetting Agents in Cleaning and Plating Solutions".

E. T. Candee, Waterbury, Conn., a movie on copper production, "From Mine to Consumer", released by the American Brass Co., and a description of plating done by the Waterbury Branch.

PLATERS PRAISE RACK INSULATION

UNICHROME RACK COATING-W

**"FINEST MATERIAL I EVER
USED" LICENSEE SAYS**

NEW YORK, JANUARY 1.—Much attention is being attracted in the plating field by the ability of United Chromium's "Unichrome" Rack Coating-W to provide perfect rack insulation over long periods of severe, continuous service without deterioration. Leading platers report this rack insulation to be "... Finest material I ever used!" — "No sign of breakdown after 1000 plating cycles" — "Racks in perfect condition after three months" — "Easy to rinse" — "Perfectly satisfactory!"

UNICHROME* RACK COATING-W

Important advantages of this plating rack insulation—advantages which users verify—are:

1. Withstands boiling cleaners and all plating solutions
2. Tough—withstands wear and tear of handling
3. Contains no ingredients harmful to plating solutions
4. Cuts costs—reduces frequency of re-coatings

5. Easy to apply—"dip and force dry" method

6. Light in color—easy to see how well the rack is covered

7. Any part of rack can be recoated without recoating entire rack.

Write for Bulletin 31

Containing Complete Information—

Platers without rack coating facilities may have their racks coated with "Unichrome" Rack Coating-W by Chromium Corporation of America, 4645 West Chicago Avenue, Chicago, Ill. Belke Manufacturing Company, 947 North Cicero Avenue, Chicago, Ill. or Lea Manufacturing Co., of Waterbury, Conn.

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FREE Directions For Stripping COPPER from Zinc Die Castings with

McKEON'S "Liquid Sulphur"
SULPHUR PRODUCTS CO.
Greensburg, Pa.

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"We Won't Know Beans"—'til we go to Boston — June 9-10-11-12.

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MY FINISHING COSTS ARE TOO HIGH.....!

Use Globe Tilting Tumbling Barrels for fast cleaning, finishing, and japanning. Patented work-shifting bottom provides 6 way tumbling action. Five sizes—motor or belt driven—cover a wide range of uses.

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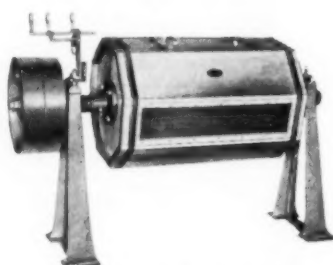
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OUR PLASTIC PRODUCTS REQUIRE A TOTALLY DIFFERENT FINISHING METHOD

The Globe Horizontal Barrel for Plastics will remove fins and enhance the luster of delicate plastic objects. Eliminates costly hand processing methods. Shell is constructed of 1½" kiln-dried maple. Motor or belt drive.

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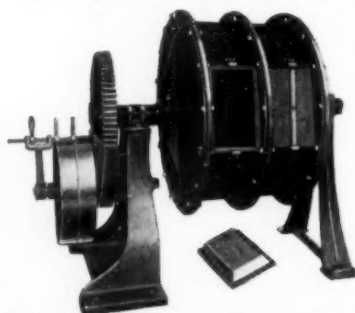
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WE COULD SPEED ASSEMBLY BY FINISHING DIFFERENT PARTS SIMULTANEOUSLY

Globe Compartment Burnishing Barrels can finish one, two, or three different parts for the same assembly thereby speeding production. Exceptionally strong and durable. Large doors for fast loading and unloading. Motor or belt drive.

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Globe Compartment Burnishing Barrel

FREE! Globe's new illustrated catalog B-61 is yours for the asking. Packed full of interesting information, it demonstrates how you can slash your finishing costs. Write today!

GLOBE MACHINE AND STAMPING CO.

1250 WEST 76th STREET, CLEVELAND, OHIO

The annual banquet followed by entertainment and dancing begins at 7 P.M.; tickets \$2.50.

C. T. Thomas is secretary-treasurer.

Chicago Branch

The branch will hold its annual educational session and banquet at the Palmer House, Chicago, Saturday, January 25th. The educational session will start at 2 o'clock with the following speakers and subjects:

Joseph B. Niles, Research & Development Engineer, Thos. J. Dee Co., Chicago, "Industrial Applications for Gold".

Frank K. Savage, Research Chemical Engineer, C. G. Conn., Ltd., Elkhart, Ind., "A Development in Full Automatic Silver Plating".

R. J. Hazucha, The Clinton Co., Chicago, "The Value of Lacquer Film Thickness".

G. J. Berry, Electric Products Co., Cleveland, Ohio, "Generators and Rectifiers".

A banquet, entertainment and dance will be given in the evening, with all seats reserved at a charge of \$3.50 each.

E. A. Lanz is secretary-treasurer.

Detroit Branch

Almost 1,000 persons attended the 4th annual meeting of the Detroit Branch.

Prominent men to address the branch were:

Dr. C. F. Kettering, vice-president and director, General Motors Corp., Detroit, "The Application of Modern Science to the Plating Industry".

Dr. F. A. Rohrman, Michigan College of Mining & Technology, "Vagaries of Corrosion Testing".

Floyd F. Oplinger, Dupont Co., Niagara Falls, N. Y., "Copper Plating".

Prof. Edwin Baker, University of Michigan, presided, being introduced by Walter L. Pinner, president of the branch.

In the evening an elaborate banquet and floor show occurred followed by dancing to an excellent orchestra. A 120-page official program was published and a feature of the program was the history of the Detroit Branch, compiled by W. W. McCord, branch historian.

Members from other branches from Milwaukee to Boston were in attendance.

At the February 7th meeting of the branch, E. A. Anderson of N. J. Zinc Co., Palmerton, Pa., and M. R. Caldwell, W. B. Jarvis Co., Grand Rapids, Mich., will discuss "Electroplating of Zinc Base Die Castings".

Grand Rapids Branch

The branch will hold its fourth annual dinner and dance January 18.

The educational session is as follows:

Paul R. Pine, Harshaw Chemical Co., Cleveland, "The Finishing of Die Castings".

W. M. Phillips, General Motors Corp., Detroit, "Weather as a Corrosion Test".

O. S. True, U. S. Rubber Co., "The Uses of Rubber in the Electroplating Industry".

J. P. Butterfield, American Rolling Mills, "Electropolishing of Metals".

A dinner dance will be held in the evening with a floor show and dancing to Romanoff's orchestra; tickets \$2.00 per person.

Hartford-Waterbury Branches

The above named branches held a joint meeting on December 13, 1940, at Hotel Elton to hear Dr. J. E. Stareck, Chemist, United Chromium, Inc., Waterbury, present the first public discussion and exhibit of "Electrocolor" and "Patternplate".

The meeting hall was crowded with interested listeners and the talk was followed by an extensive discussion with some remarks by Bert Farr, superintendent, Manning-Bowman Co., Meriden, Conn.

George Heinrich was technical chairman.

Newark Branch

On January 3rd, Dr. C. J. Wernlund, Dupont Co., Niagara Falls, N. Y., addressed the branch, the subject of his talk being "A Study of Tin Plating Solutions".

The speaker at the January 17th meeting will be G. Byron Hogaboom, Jr., who will discuss "Simple Tests for Determining Thicknesses of Copper, Nickel, Tin, Zinc and Cadmium."

New York Branch

The branch will hold its annual educational session and banquet on Saturday, February 22nd. The session will be called "Founders' Day" in honor of Charles H. Proctor, founder of the Society.

The scene of the meeting will be the Mad Hattan Ballroom of the Hotel Pennsylvania. An interesting and informative educational session and fine dinner in the famed Mad Hattan Room have been scheduled, including an entertaining floor show and an orchestra; a week-end holiday party for the metal finishing industry.

Franklyn J. MacStoker, 25 Princeton Street, Garden City, L. I., is general chairman.

Toronto and Buffalo Branches

International Joint Educational Session and Banquet

These two branches will hold a joint educational session and banquet on February 8, 1941, at Fox Head Inn, Niagara Falls, Ont., Canada. The educational session will start at 2 P.M., with the following speakers and subjects:

Frank C. Mesle, "Silver Plating to Standard Specifications"

George B. Hogaboom, Sr., "Bright Nickel Plating"

Floyd F. Oplinger, "Copper Plating"

F. E. P. Griggs, "The War Influence on the Cleaning and Plating of Metals"

Tickets are \$2.00 (stag).

Electrochemical Society

The Spring meeting of the Society will be held at Hotel Cleveland, Cleveland, Ohio, April 16-19.

R. S. Mackie is chairman of the society's local committee. A feature of the meeting will be a visit to Nela Park, headquarters of General Electric Company's Lamp Department.

Obituaries

Col. Jos. H. Hansjosten

The industry was grieved to learn of the death of Col. Joseph H. Hansjosten, who died of a heart attack on December 15, 1940, at the age of 66 years.

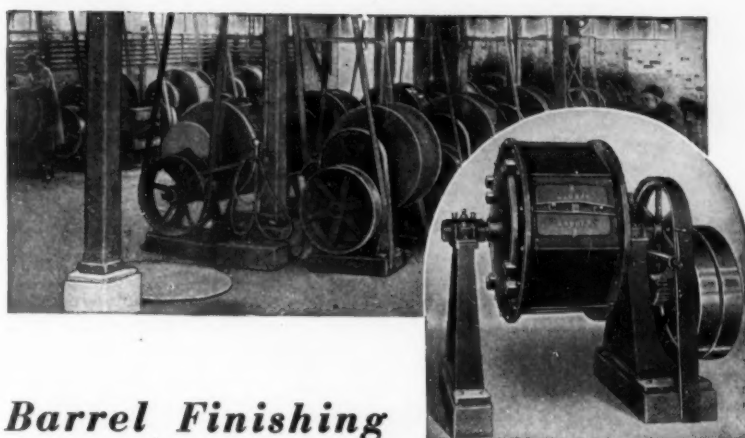


Joseph H. Hansjosten

He had been ailing for the past four years, but was able to work until the Friday preceding his death. Mr. Hansjosten was the second Supreme President of the American Electroplaters' Society, and was interested in the plating industry through almost his entire working life.

Frank B. Hamerly

Frank B. Hamerly of Aurora, vice president of the Independent Pneumatic Tool



Barrel Finishing

... meets the pace set by production

HEAVIER production schedules must be met by all departments . . . or deliveries are disrupted, customers dissatisfied.

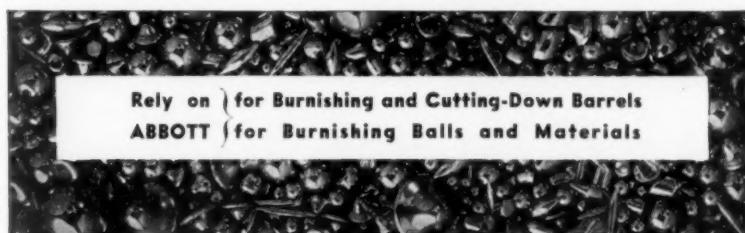
Leading companies have solved that problem with Abbott Burnishing Barrels. That is the practical, profitable way to keep finishing output in step with the rest of the organization.

Low cost, fast production, uniform results. Those advantages are reported by customers whose installations range from one to twenty Abbott Barrels.

The high, narrow body confines the load within a vertical area. Pressure of the burnishing materials is directed on the work—none is wasted. That concentrated pressure is the backbone of successful burnishing.

Tell us about your problems of finishing small, metal parts. Send us a sample or two so that we can make definite recommendations. For many companies, this free service has been the first step toward lower finishing costs.

THE ABBOTT BALL COMPANY 1046 New Britain Avenue HARTFORD, CONNECTICUT



Rely on } for Burnishing and Cutting-Down Barrels
ABBOTT } for Burnishing Balls and Materials

Company of Chicago, died November 27th of a heart attack while inspecting the company's plant at Los Angeles, Cal. Mr. Hamerly was 53 years old. He had lived in Aurora, where the company has a plant, for the last 28 years. His home was at 82 South 4th Street in the suburbs. He was the husband of Mrs. Mable Hamerly and the father of Joseph Hamerly and Mrs. Harry Callahan.

Edwin G. Lovering

Edwin G. Lovering, well known in the electroplating industry, died the latter part of November in Jackson, Mich. He was a native of Massachusetts, and started in the plating business when a boy in a bicycle factory in that state. He later had charge of the plating plant of the Buick Motor Company at Jackson, Mich. He worked in De-

troit for many years, both in plating and consulting work.

Those who knew him agree that the plating industry has lost one who was always willing to help a fellow-member and one who always looked on the bright side of life. Mr. Lovering contributed to the early issues of Metal Industry—Theodor Eichstaedt.

Personal

Richard F. Teeling has been promoted to assistant sales manager of the N. J. Division of Manhattan Rubber Mfg. Division, Raybestos-Manhattan, Inc., Passaic, N. J. Mr. Teeling has spent 28 years with the company, and in recent years, on special assignments in the rubber manufacturing field.



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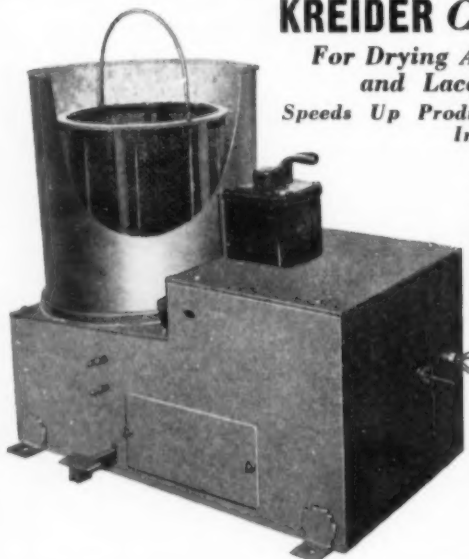
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Business Items

Du Pont Company Manufacture Potassium Cyanide

It has been recently announced that the R. & H. Chemicals Department of E. I. duPont de Nemours & Company, Wilmington, Del., have begun the manufacture of potassium cyanide. The development was prompted by current U. S. needs, and the urgency for national self-sufficiency. American raw materials will be used exclusively.

Potassium cyanide is important in heat-treating and in electroplating. It is also used in engraving and lithography.

Metaplast Corp., have announced removal of their offices and laboratory, on the first of the year, from 244 5th Ave., New York, to 205 West 19th St., New York. The corporation market a process for plating upon plastics and other non-conductive materials.

Foote Mineral Co., 4041 Ridge Ave., Philadelphia, Pa., has announced that Otto Kessler, has joined the company's organization. Mr. Kessler, a chemical engineer and for many years with the General Chemical Co., will devote most of his time to production problems of the chemical division of the Foote Mineral Company.

Adel Precision Products Corp., 231 S. Olive Ave., Burbank, Cal., has let general contract for a one-story addition, about 27,000 sq. ft. floor space. Cost close to \$75,000 with equipment. The following departments are operated: pickling, cleaning (alkaline), degreasing (solvent); anodizing. The principal base metals used are steel, brass, bronze and aluminum.

General Motors Corp., have contracted with the Metals Protection Corp., Union Title Bldg., Indianapolis, Ind., for the use of the latter company's U. S. Patent No. 1,645,927, commonly known as the reverse current process of hard chromium plating. This process will be used by General Motors in its program of hard chromium plating as a means of salvaging worn machine parts and increasing the life of dies, gauges and molds. This program, originally tested on a production basis by General Motors Corp. at their Delco-Remy plant, is now being extended to other plants operated by the corporation.

Courses In Electroplating & Metallurgy

The Institute of Electrochemistry and Metallurgy, 59-61 East Fourth Street, New York City, will offer specialized courses in the field of electroplating and metallurgy during 1941. Registration will be held for the Spring courses from February 6th to February 10th inclusive and the first class meeting will occur on February 7th. The following studies will be offered:

Electroplating II.

This course is designed to give the elec-

troplater a knowledge of the ways and means of obtaining better deposits by applying the latest scientific methods of electrochemistry to electroplating. One hour of each evening will be devoted to a lecture on the theoretical aspects of the subject and two and one half hours will be spent in the laboratory where the student will apply the principles set forth in the lecture. Copper, nickel, zinc, cadmium, chromium, silver, and brass will be deposited from aqueous solutions. While plating the above metals, the factors governing the character of the deposit such as current density, temperature, pH, etc. will be noted. Other experiments will include throwing power, single electrode potential, addition agents, resistance of solutions, anodizing and coloring aluminum, corrosion tests, etc. After these are complete the student will prepare standard solutions and make analyses of all the important constituents of the above plating baths. Tuesday and Wednesday, 7:30-11:00 P. M. Prerequisite: Electroplating I. or its equivalent. Dr. Young and Mr. Klinseich.

Metallurgy II. (Metallography):

This course is designed to teach the student preparation of metallographic samples for microscopic examination. Various samples of different metals and alloys will be polished, etched, and examined under the microscope. The detection of faulty alloys and metals will be stressed. Dr. Young and Mr. Klinseich. Tuesday and Wednesday, 7:30-11:00 P. M. Fee: \$25.00.

Research II:

This course is designed to give the practical electrochemist a chance to investigate problems in his field. One half hour per week is devoted to a conference with the instructor in which the method of attack is laid out. The remaining time is spent in the laboratory where the student applies his knowledge and technique to the solving of problems which arise in such an investigation. Tuesday and Wednesday, 7:00-11:00 P. M. Dr. Young. Fee \$30.00.

Industrial Microscopy IIA:

This course is specially planned in photomicrographical analysis, general microscopy, and instruction on the metallographic microscope. Subjects covered include the preparation of materials and the proper selection of optical equipment, methods of illumination, control of glare, illumination by incident light, and the use of color filters, special methods of particle-size determination, determination of refractive index, micrometry, and the proper use of mounting media with respect to its relative refractive index. Work with the polarizing microscope may also be arranged. Mr. Shillaber. Tuition and laboratory fees, \$55.00. Hours to be arranged and announced later.

Time payments may be arranged if desired. For further information call Dr. C. B. F. Young, ORchard 4-1778 or FLushing 9-1685. For men outside the New York area a special course has been written on the subject of chemistry and electroplating. Further information can be obtained by writing to Dr. Young, Box 292, Flushing, N. Y.

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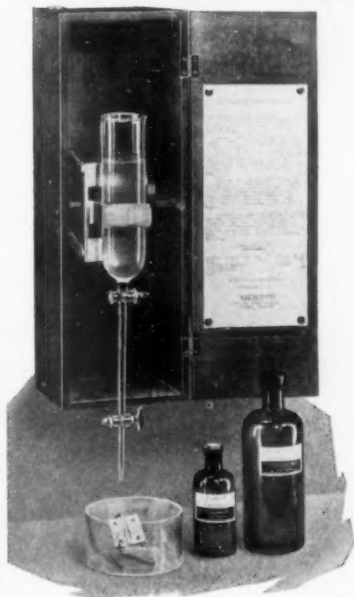
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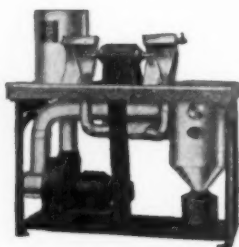
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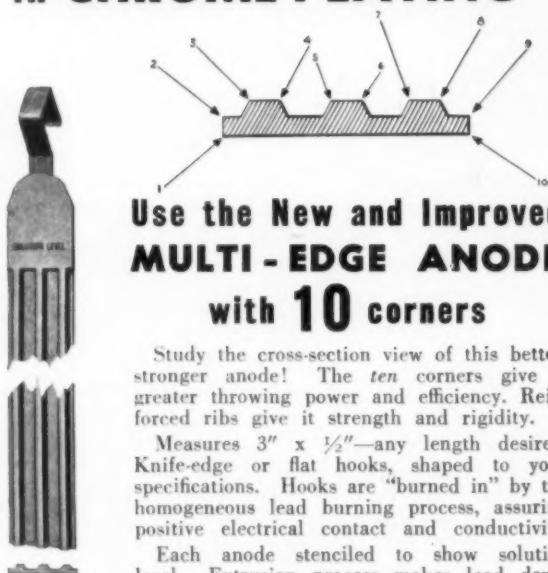


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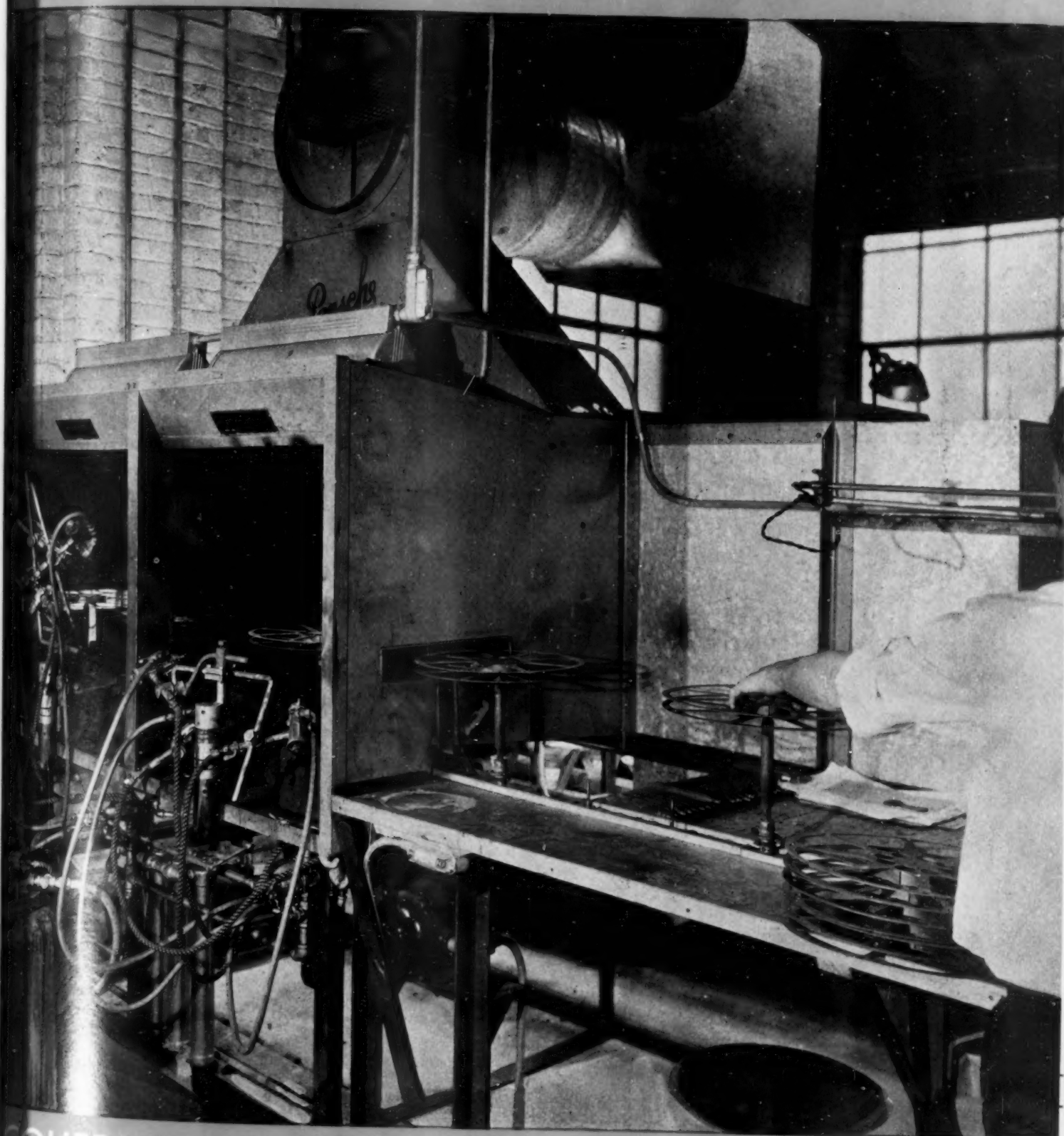
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Waterbury, Conn.

JANUARY, 1941

ORGANIC FINISHING

SECTION OF METAL FINISHING



QUERING • ENAMELING • JAPANING • PAINTING



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Perspiration*
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by
ZAPON

Pitted against perspiration, flashlight cases used to come out second best. Two hours was the limit before the best finish broke down under constant handling. So when quality-wise Winchester Repeating Arms Company turned to making their line of brass and bronze flashlights, they asked Zapon for a real perspiration resistant finish.

XL-516-EE is a clear metal lacquer, that may be hand sprayed and air-dried or applied on automatic spray machine and force dried for a short time. Besides offering a finish with valuable specific properties, its story is another saga of Zapon service.

The answer was XL-516-EE clear finish which increased the hours of sweat resistance 45 times. But it took nine months of work and ingenuity. Since there is no adequate synthetic perspiration test we coated flashlights with the new finish and had our laboratory men carry them about their work and handle them until the finish broke down.

As a result of this research, XL-516-EE stands up for 90 hours in the constant handling test. Better yet it has served without complaint for several years in the field, on thousands of flashlights.

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Section of
METAL FINISHING
*Founded January, 1903
as Metal Industry*
Publication Office
116 John Street, New York

ORGANIC FINISHING

SECTION OF METAL FINISHING

JANUARY, 1941

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Illustration on Cover

The illustration on the cover is used
through the courtesy of Paasche Air-
brush Co., Chicago, Ill.

Staining of Silver

It is well known that electroplated silver and Sterling silver objects readily stain on contact with sulfide type materials, or free sulfur, forming either brown or black stains. Frequently, clear lacquer or enamel films are applied to the silver in an attempt to obviate this staining. Special materials have been developed that are relatively non-permeable to hydrogen sulfide.

The stains occurring on silver may be either of a general nature or isolated spots. The general tarnishing occurs unduly rapidly when objects are exposed to sulfurous gases, such as from the burning of coal, fuel oil, etc. One of the chief causes for the isolated spot type of staining is the use of sulfur-bearing paper. For wrapping either lacquered or unlacquered silverware, the sulfur content of the paper should be less than 0.0001%. Paper containing higher quantities of sulfur may induce staining of the silver in from one day to several months. The paper can be analyzed for sulfur by either an evolution method or by a practical method, which consists in moistening the paper with distilled water and pressing it between two clean polished silver plates for at least 24 hours. Good paper will not cause any spotting on the silver within that period of time.

Lacquer manufacturers have been held responsible for rapid staining of lacquered silverware, but usually the factors contributing to the stains are those outlined above, although there may be the remote possibility of the lacquer or enamel solvents containing sufficient quantity of sulfur or sulfur-bearing compounds to cause staining.

DEVELOPMENTS OF 1940 IN THE ORGANIC FINISHING FIELD

By Walter R. Meyer, Ph.D.

Editor, Metal Finishing

The industrial finishing industry is playing an important part in the National Defense program. Organic finishes are used principally for the following purposes:

1. *Corrosion protection.* Much of the material used in the rearmament program must withstand outdoor exposure, and corrosion resistant finishes are playing an important part in maintaining the life of armament parts.

2. *Identification of equipment.* Different colors are widely used for identifying various types of shells, bombs and other materials.

3. *Rendering equipment inconspicuous.* The general use of organic finishes for camouflaging is well known. However, there has been an increased interest in the development of special varnishes for application to airplanes to render them difficultly discernible, especially at night. In addition, dull finishes are used for suppressing the reflection from smooth and polished surfaces.

Extensive work has been done during the year revising specifications for preparation of the surfaces previous to finishing, specifications on finishes and methods for testing the same.

Cleaning

Finishes with good outdoor corrosion resistance and long-life require that the surface preparation be complete. In this respect, cleaning is particularly important and new equipment has been developed for solvent degreasing of parts. Irregularly shaped objects frequently have been found to be expensive to clean by solvent degreasing methods because of excessive drag-out. However, new machines have been devised for cleaning of cup-shaped articles, the machines employing rotating baskets to empty the solvent from the recesses.

A reduction in solvent cleaning costs is possible by the use of reclaiming systems and a special solvent still has been put on the market for the reclaiming, at a low cost, of such solvents as naphtha, benzol, paint and lacquer thinners.

The developments in alkaline cleaning materials have kept pace with the demand and several new materials were announced suitable for the cleaning of aluminum, without attack. Emulsion spray cleaning became more widely used, particularly in cleaning previous to the phosphate coating treatments. In emulsion spray cleaning, alkalies are not used. The materials consist of solvents with suitable emulsifying agents and the mixtures are used in high dilution with water. They have proved to be particularly effective in removing smut by spray washing.

Metal Surface Preparation

Several lightweight portable electric sanding machines were developed. The sanders feature the use of light alloy metals which reduce fatigue in handling the sanders. For disc sanding, a lightweight back-up pad has been developed in 7, 8 and 9-inch sizes, which has a molded plastic center with the flexing surface made of rope fibre bonded and molded to prevent separation.

Metal Surface Treatment

It is becoming rather well recognized that a superior organic finish requires the use of a special surface treatment process, such as anodizing for aluminum and the phosphate coatings for steel. Treatments have been developed and are being used for magnesium alloys, zinc alloys and zinc and cadmium coated surfaces. A material marketed for treatment of galvanized



Wrinkle finishes being baked with infra-red lamps.

(Courtesy, New Wrinkle, Inc., Dayton, Ohio)

coatings previous to organic finishing involves the addition of the chemical to the surface which is said to result in a hard, inert etched surface, making it particularly receptive to finishing.

A low cost non-electrolytic method of producing a hard, smooth and tenacious coating on aluminum was also announced. The solution for the process is furnished ready for mixing with water, and the process is substantially a simple immersion one. Because of the immersion nature of the process, complete coverage of treatment on the part is obtained.

Infra-Red Finishing

The use of the infra-red baking process and special finishes for infra-red baking, spread rapidly during the year. The process involves the use of heat radiated by electric lamps instead of baking the parts in an oven. The advantages and limitations of this process have now become well understood. The method is particularly useful in mass production work where pieces of the same size and shape are being



Some types of infra-red lamps.

(Courtesy, Westinghouse Elec. & Mfg. Co., Bloomfield, N. J.)

turn out, but it is not suitable for handling products that vary greatly in physical dimensions. It is not expected that this method will supersede other baking processes but will find a definite field based on certain unique characteristics.

Formulations have been developed for infra-red baking which include both undercoats—primers and primer surfaces—and top coats in a full range of colors with no limitation as to lustre. Hammer effects, wrinkle effects and other finishes are now available for infra-red baking. In many cases speed schedules have been noticeably increased and in one case, for example, the ordinary bake of 15 minutes at 300°F. was lowered to 5 minutes by the use of an infra-red lamp set-up. The process requires special heat lamps, which are offered in various watt sizes from 250 to 1000 watts.

The rated life of the new drying lamps is in excess of 5,000 hours. One lamp featured is a self-contained lamp in which a metallic reflecting coating is applied to the inside of a specially shaped glass bulb, thus protecting the reflector from dust, moisture and deterioration. Its rating is 250 watts.

Several companies have offered gold plated reflectors, with special devices for holding them, to the trade. Reflectors featuring "Alzak" aluminum surfaces for reflection have been announced. It is claimed that these specially treated high purity aluminum surfaces have nearly the same reflectivity as gold, and are more nearly permanent than gold.

New Finishing Materials

Although there was special interest in the development of finishes for infra-red baking, as mentioned above, numerous other new products were put on the market for giving improved or more beautiful finishes. A new finish resembling beaten metal has been made available in copper, bronze, silver and other ornamental metallic colors, for use on a wide variety of products made of metal and plastic.

It was found that a marked cheapening in cost of plastic materials could be effected by the use of cheap plastic compositions which were subsequently finished with the color desired. This required the development of special materials for adhesion to the plastics, and these materials are now available.

Effort was made to develop synthetics capable of being baked

at low temperatures. Several new synthetics have been announced possessing the desirable characteristics of synthetic enamels together with low baking qualities. Some of the other new products were: perspiration-proof lacquers for articles which are to be handled and must resist the corrosive action of perspiration; a line of white and colored enamels for stoves which will stand high temperatures and have good resistance to marring, hot grease and kerosene; aluminum baking and air drying synthetics, which are said to produce coatings closely resembling dull chromium plated surfaces; and a special abrasion resisting enamel available in all colors for the treatment of concrete floors.

A finishing schedule for the rapid application of wood grain on metal was devised. It consists of a quick drying primer which resists the grain-ing ink, and a top coat of air drying or quick baking clear lacquer.

Chlorinated rubber base materials, both air drying and baking, were improved. A new line of air drying chlorinated rubber base enamels features dust-free drying in a few minutes and hard overnight drying under normal conditions. Good adhesion and outdoor weather resistance are claimed.

Clear coating materials developed have been numerous. This has been occasioned by the increasing availability of new synthetic resins, solvents and plasticizers. One new coating material features high lustre, clear water-white appearance, good adhesion, flexibility and abrasion resistance, as well as fast drying. The material is also stated to have good resistance to sulphur dioxide, sunlight, moisture, oil, grease and common chemical fumes.

Shellac coatings are claimed to be improved by a new shellac fortifier, which is stated to increase the abrasion resistance to more than four times that of the same shellac without the fortifier. Use of the fortifier is also stated to decrease the drying time and to effect a marked reduction in permeability to moisture.

Enamel Stripping

The increased use of high bake enamels has resulted in increased difficulty in stripping. Materials have been developed which strip most synthetic enamels satisfactorily, with the possible exception of certain high bake phenol formaldehyde materials which

appear to be resistant to almost all chemicals, and which have been applied to such objects as washing machine activators.

Caustic strips have been used for removing finishes from steel, but are not satisfactory for stripping finishes from such active metals as zinc. New strippers available enable clean stripping from zinc, aluminum and other active metals without attack. In addition, pigment film is not deposited as is the case with alkaline stripping, thus obviating the necessity for hand wiping. Special alkali stripping materials are available for Gilsonite japans, and for the stripping of lacquers and certain enamels. Stripping of finishes is particularly important in the aircraft field, especially of engine parts as the re-finishing operation is a periodic job in the proper maintenance of aircraft and thus, in aircraft finishing, stripping characteristics of the enamels used, must be considered.

Equipment

Spray Guns: Many improvements in spray guns were announced during the year. Two new guns for the spraying of flock were developed. The flock is made from finely cut rayon, cotton or wool, and is used to produce a velour or suede-like finish, which is sprayed on after coating of sizing material has been applied to the surface.

One model of gun has an oil and moisture filter included in the handle of the gun, obviating any difficulty



(Courtesy, The Electric Sprayit Co., Sheboygan, Wis.)



Spray guns for spraying flock.
(Courtesy, Paasche Airbrush Co., Chicago, Ill.)

from dampening of the flock.

An extension spray gun for painting large surfaces beyond the reach of the operator was marketed. The gun is supplied in lengths up to 12', enabling the painting of the average wall and ceiling without having to climb.

Portable Equipment: To enable the sprayer to have the facilities of a central dispensing system, a portable unit has been devised. It contains a tank provided with an electric motor driven mixer. The unit is said to be particularly good for special colors and for short runs of standard colors.

A new $\frac{1}{2}$ H.P. portable air compressor has been announced, capable of delivering 4.55 C.F.M. at 45 pounds pressure. Four rubber-tired swivel casters enable ready removing of the 72 pound unit. Several portable spray painting outfits were made available;



$\frac{1}{4}$ H.P. spray painting outfit.
(Courtesy, Binks Mfg. Co., Chicago, Ill.)



Portable air compressor.
(Courtesy, The DeVilbiss Co., Toledo, Ohio)



Automatic tube sprayer.
(Courtesy, Eclipse Air Brush Co., Newark, N. J.)

one features a twin cylinder compressor driven by a $\frac{1}{2}$ H.P. motor with 5.10 C.F.M. displacement and a spraying pressure of 40 pounds. Other units of portable spraying equipment of five different sizes were announced.

Automatic Equipment: The cry today is for faster and faster spray finishing production, and that cry has been met by the development of machines and equipment, having capacities far beyond that of the hand-operated spray gun.

Rotary spray finishing machines have been installed for doing as many as 3600 small lightweight articles an hour. The rotary machine employs the basic principle of rotating the product to be finished before one or more spray guns so mounted that the spray is properly directed to reach all exposed surfaces.

Horizontal transverse machines have been developed for applying finish at the rate of 240 sq. ft. per minute on curved or flat surfaces. One manufacturer finishes 3000 camera parts an hour; another does 1200 lamp shades. Pipe is painted at a rate of 200' a minute; shingles coated, two a second.

One automatic spray unit built was for coating the inside and outside of steel tubes, 4" long and 1" in diameter. Another unit was designed for finishing over 11,000 motor ends per eight-hour day. This unit was equipped with dual air coating stations for applying primer and finishing coat, with the unit being used in conjunction with a continuous type high temperature drying oven.

Testing Equipment

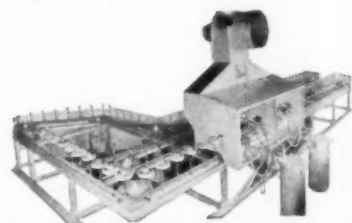
The non-destructive testing of the thickness of organic finishes has been made possible by the development of a magnetic testing instrument called the "Magne-Gage". The measurement is based on the loss of magnetic attraction between a permanent magnet and the base metal with decreasing attraction as the thickness of the coating increases. Instruments are readily calibrated to suit various ranges of thicknesses.

A new model explosimeter has been offered to indicate the presence of combustible gas without subjecting the atmosphere to danger of ignition.

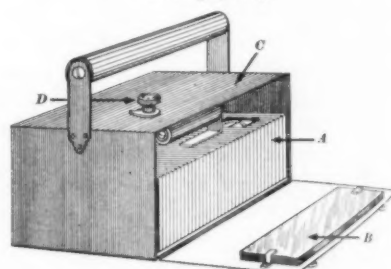
A portable glossmeter, designed primarily to test samples for compliance with specifications for gloss and to measure changes in gloss of surfaces

resulting from weathering, wear, abrasion and other treatments, has been announced.

Names of manufacturers or suppliers of equipment or processes mentioned in this review, can be obtained by writing Metal Finishing, 116 John Street, New York, N. Y.



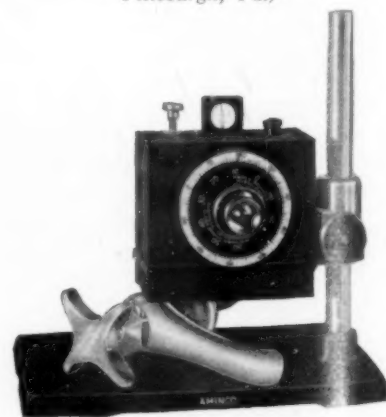
Unit for air painting motor ends.
(Courtesy, Paasche Airbrush Co., Chicago, Ill.)



Portable Glossmeter
(Courtesy, Henry A. Gardner Laboratory, Inc., Washington, D. C.)



Combustible gas indicator.
(Courtesy, Mine Safety Appliances Co., Pittsburgh, Pa.)



Magnetic thickness gauge.
(Courtesy, The American Instrument Co., Silver Spring, Md.)

Modern Organic Finishing of Maytag Washing Machines

By The Maytag Co. Technical Staff

Newton, Iowa

This paper describes the selection and development of finishing materials and equipment for applying modern, high standard finishes to the Maytag washing machines. Tests for evaluating finishes are described. The processing equipment is described and illustrated.—Ed.

When the Maytag Laboratory was ordered to develop a nearly perfect a washing machine finish as was possible, it knew it had a job on its hands. That finish must not be thermoplastic, must stand strong alkali, be practically impervious to humidity and to salt spray and, of course, must provide a splendid lustrous covering for the entire machine. And—it must handle easily in production.

The research toward the development of the new finish started at the

same time as the engineering work was begun on the new Maytag "Master", shown in Figure 1-A. The first problem was to set up proper tests, tests which would go far past any of the actual conditions the finish might be expected to withstand in the field. The tests finally selected and developed were as follows:

Salt Spray Test. This test consists of standing the panels in a rack at a 30° angle, using a spray of 20 per cent salt solution, at room temperature. Prior to going into the salt chamber the panels are scratched and observations made as to how far back from the scratch rust occurs. The duration of this test is 200 hours.



Fig. 1-A. The finished product—a gleaming, white, enameled washing machine.

Humidity Test. The panels are placed on a wooden rack at a 25° angle in an insulated cabinet. The atmosphere is kept at 100 per cent relative humidity, at a temperature of 115 to 120° F. During this test observations are made for blisters or any other failure. Duration of this test is 200 hours.

Alkali Test (6-hour Test) The panels are placed in a 2 per cent alkaline solution made up of 0.1 per cent sodium carbonate and 1.9 per cent of a good grade of soap. The solution is heated to 160 to 170° F. The panels are checked at regular intervals for discoloration, blistering, softening of the finish, or any other defect. Along with these panels are run another set, placed in the same solution, same temperature, and these are removed at the end of 1½ hours, washed, and allowed to cool for at least two days before being checked for adhesion, gloss, and other qualities.

Adhesion and Elasticity. A test which has played an important role

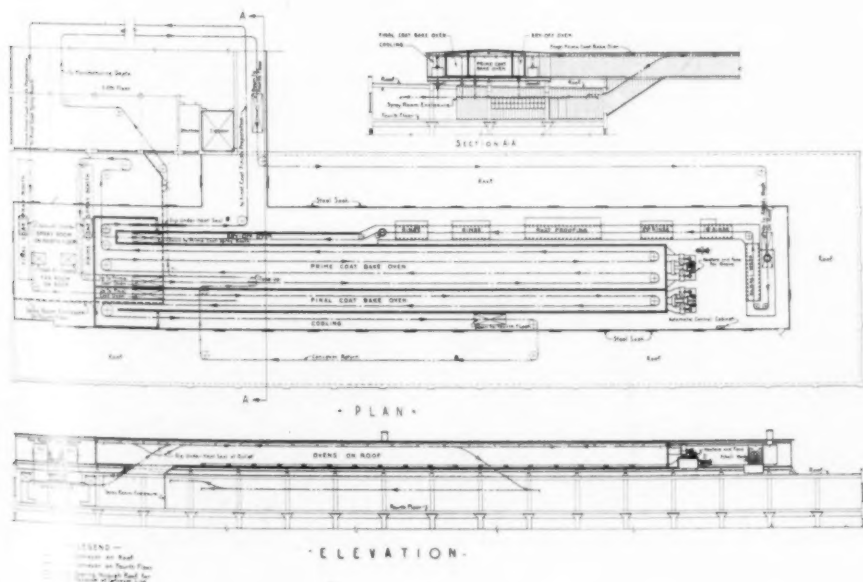


Fig. 1. Diagrams of finishing cycle for washing machine. The illustrations used in this article are through the courtesy of R. C. Mahon Co., Detroit, Mich.)



Fig. 3. Full length view of the painting and rust proofing equipment.



Fig. 4. Hydro-filter type of spray booths.



Fig. 5. As the parts leave the spray booth, they are returned to the roof through the bottom seal as shown.

in developing the Maytag finish, and which is still useful in demonstrating its superiority, has been the elasticity test. The apparatus developed in the laboratory for this purpose, is composed of a ball and socket. The ball is mounted so that it can be made to press into the socket at a fixed distance, thereby stretching the surface, as indicated in Figure 11. This is also used as an indication of the adhesion of the finish, along with scratch tests, which are more or less standard with all paint users.

Alkali Abrasion Test. This has been outstanding in the results produced. It was developed in its entirety in the Maytag Laboratory and consists as shown in Figure 12, of an arrangement whereby canvas strips are drawn over the finished panels. The strips are pressed to the panels by the use of $4\frac{1}{2}$ pound weights. The canvas strips dip into a solution of 0.5 per cent sodium pyrophosphate kept at a temperature of 165 to 170° at all times. The test is run for a dura-

tion of 40 hours, and close observation is made for the wearing of the finish, blisters, and other defects that can be expected from a test of this nature.

Other tests of a general nature are roof exposure, where panels are exposed to atmospheric conditions, hardness test, using the Sward hardness tester; throughout all tests discoloration and gloss are observed closely. The valuation of the tests has been set up as follows:

Humidity	20	per	cent
Alkali	20	"	"
Alkali abrasion	20	"	"
Original adhesion	16	"	"
Original gloss	16	"	"
Salt spray	8	"	"

With the tests fully developed the next step was to obtain a finish to pass satisfactorily. Twenty-five manufacturers were asked to submit samples, with knowledge of the above tests, and some 60 different materials were submitted, but none were found acceptable in their entirety. In a short time, however, with the aid of the company's

laboratory, several finishes were developed which passed the tests satisfactorily. Up until this time no equipment had been installed and, since the equipment was to be completely new and modern, a wide range was given on selection of processing schedules and methods of handling the parts. There were the problems of coatings, metal preparation, rust-proofing, baking, and many others, which, when finally determined, formed the technical basis for the design of the new Maytag finishing system which is thought to be the best of its kind.

Figure 1 shows completely the outline and setup of the equipment. The parts are loaded at Station 1 and carried to the roof, where they enter the alkali washing machine. Then into the two rinses, the rust-proofing solution, a third rinse, and a final chromic acid rinse, before entering the dry-off to be returned to the fourth floor and receive the prime coat.

Figure 3 is a full length view of the painting and rustproofing equipment. Its features are straight line travel, automatic stem regulation of all tanks, pressure and temperature indicators on

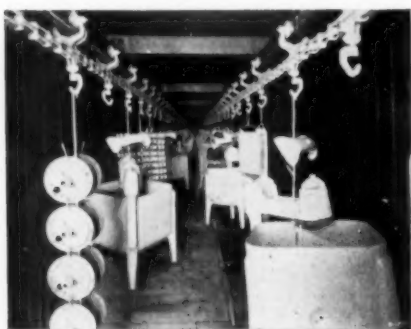


Fig. 6. View showing the washers in the final coat oven. On exit from the oven, they pass through a cooling tunnel on the roof before returning to the 4th floor.

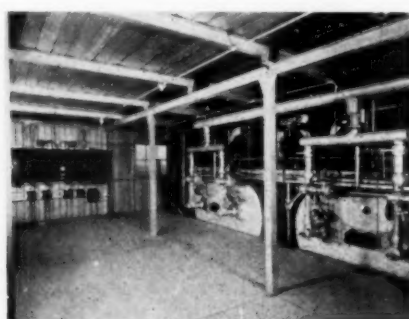


Fig. 7. View of the burner system and its control board. Both ovens are fired with butane gas direct. There are two burners for the prime coat and two for the final coat.

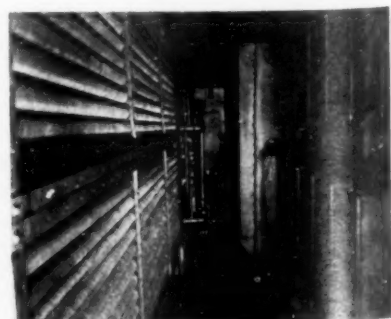


Fig. 8. View of air heaters. These coils are the non-freezing type using 100 lbs. pressure steam for heating air from 20° below to 60° above.

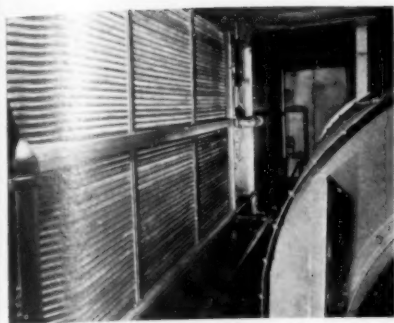


Fig. 9. Large centrifugal fan which sends the washed and tempered air to the spray room. One-half of blower shown on right.

all pumps which with constant chemical and process control, produces a completely uniform and highly satisfactory overall result.

The spray booth as shown in Figure 4 is of the latest hydro-filter type, using the Mahon principle of flood sheets and special spray arrangement to insure complete paint removal before the air is exhausted to the outside. The water tanks for retaining the sludge are of special design to fit requirements. The primer booth is 38' long, with an exhaust capacity of 36,000 cubic feet of air per minute. Spray equipment for five operators is provided. The final coat booth is 42' long, with an exhaust capacity of 40,000 cubic feet of air per minute, and spray equipment for seven operators. A small color coat spray booth, 4' long, of the same design, is located at one end of the final coat booth. Equipment for one operator is provided in this booth. In the photograph you see the primer booth on the left, with the final coat booth on the right.

As the parts leave the spray booth they are returned to the roof through the bottom seal as shown in Figure 5. Here the parts are subjected to a 30-minute bake, at a temperature of 315° F. They are then conveyed out of the oven over a cooling tunnel and are unloaded at Station 2, shown in Figure 1. The parts are at this point placed on traveling bank conveyors which pass convenient points for unit assembly, finally terminating at Station 3 as an assembled unit and placed on the finish coat chain.

Before entering the spray booth the washers are cleaned with naphtha and are sanded lightly where necessary. They then enter the final spray booth to receive their coating of special enamel, before passing on through to

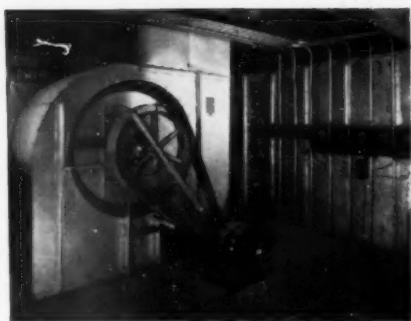


Fig. 10. View of one of two exhaust fans above spray booth.

the roof for final bake of 30 minutes at 300° F.

Figure 6 shows the washers in the final coat oven. On exit from the oven, they pass through a cooling tunnel on the roof before returning to the fourth floor and station 4, where final trim is started before unloading the washers at Station 5. From here on the washers are carried on a series of chain belt gravity roll conveyors through the final trim, inspection, crating, and to the car for shipment.

Of special interest are the heating system, the air supply, and exhaust system for spray room. Also the paint storage and mixing room.

Figure 7 shows the burner system and its control board. Both ovens are fired with butane gas direct. There are two burners for the prime coat and two for the final coat. Each burner has a capacity of 2,000,000 b.t.u. per hour, or a total of 8,000,000—

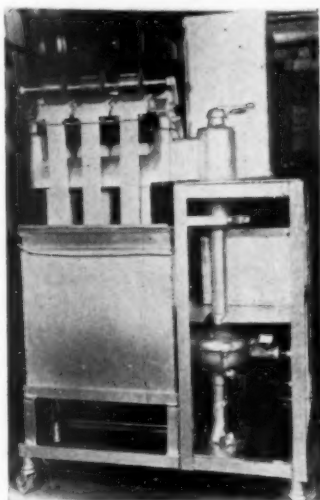


Fig. 12. View of alkali abrasion testing machine developed at Maytag. Canvas strips under pressure, wet with alkali solution, are drawn over panels.

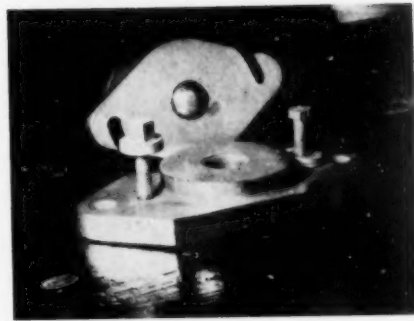


Fig. 11. Ball and socket tester for determining adhesion and elasticity of finishes.

four times the operating load. This has given exceptional sensitivity in the control and made for faster come-up time, and benefits greatly the control of shut-downs at noon and at night. It has never been necessary to empty the ovens at any time. The burners are equipped with the latest automatic lighting and safety control equipment, requiring very little supervision.

The requirement of 30,000 cubic feet of air per minute to the spray room is controlled in a room directly above the spray booth. Here the air is brought into the Aerofin heaters as shown in Figure 8. These coils are the non-freezing type, using 100 pounds pressure steam, and have a capacity for heating air from 20° below to 54° to 60° above, before entering the water wash as shown on the right. Here the air is washed, passed through the tempering coils, and sent to the spray room through the large centrifugal fan shown in Figure 9. Both Figures 8 and 9 show only one half of the equipment. The temperature in the spray room is held at 85 to 90° winter and summer, giving ideal spraying temperatures at all times. The air passing into the spray room is then filtered through glass wool as shown in Figure 8. These filters remove any possible trace of dirt which might pass the water wash.

Figure 10 shows one of the two exhaust fans directly above the spray booth, which are capable of removing slightly less air than that sent into the room by the air make-up fan, the reason being that any air currents at opening of the spray room are outward, allowing no dust to filter into the spray room.

Another feature of interest, making (Concluded on page 62)

Finishing Filing Cabinets and Allied Steel Office Units

By Frank V. Faulhaber

IN this case the grainer who operates by transfer process on a contract basis is no better positioned, when limited in equipment, than the plant using its own limited assortment of graining apparatus.

The management interested in this aspect of finishing does well when it considers the output as produced in other similar plants. By visiting various shops and examining the varied work, in conjunction with pertinent consultation, we obtain a more comprehensive idea of the varied character of workmanship turned out in this line of art. Such venture should help the seeker in deciding what type of graining to employ in his own particular plant.

There is a varied type of pleasing woods that can be simulated by the adept grainer, such as circassian walnut, chestnut, birch, oak, cherry, French burl, antique maple, bird's eye maple, and what not. Considerable of the grained work is confined, however, to bringing out effects in light and dark walnut and American walnut, and light and dark red mahogany and light and dark brown mahogany. In exceptional instances some customer may ask regarding a marble effect or whether the grained finishes can be made to resemble some specific, pleasing type of stone.

Suitable Graining Base

Initially, the steel furniture to be grained is preliminarily prepared as are the standard finished lines, removing all rust spots to provide a suitable base for the graining. Dust should be removed with a light dusting brush or a clean tack rag. Even for the specialized hand graining work there seem to be as many different methods and procedures as there are hand grainers. Each has his pet preferences and individual method of applications. A good primer or ground coat can now

This is the concluding portion of the article on finishing filing cabinets, the first part of which appeared in the Nov. 1940 issue.

Graining technique is discussed in detail

be sprayed on. The priming coat should be lacquer resistant.

Filing cabinets and most of the larger and better grades of work usually will require filling of some kind. One or two coats of filler can be worked in and then baked and then smoothed down by hand or machine. Always the working surfaces should be kept free of dust. Some manufacturers of cheaper office furniture apply but one graining undercoat. Two coats, of course, are always better.

Some finishers apply a ground color over a surfacer or priming coat; others prefer a combination baked ground and primer. Whatever the choice, the graining grounds should be very fine, of good hiding power, have even flow, and selected for adhesion. It should have the true color of the wood to be reproduced, considering its flatness or dull sheen, and have the quality of combining with the graining ink or stain. Naturally, too, all succeeding coats should enhance instead of detracting from the ground color coat.

The Graining Ground

The ground coat overlay may be an air-drying or a bake finish material. When this ground coat is dry, the surface may be given a light sanding with a very fine abrasive paper. The ground coats, when desired, can be low-baked at 175 deg. F. to 200 deg. F. for one hour, or air-dried for 24 hours. The same procedure can be set for baking the graining stain. Here, varnish may be low-baked for two hours at ap-

proximately 180 deg. F. or air-dried for 24 hours. Irrespective of the choice, a resin varnish may be employed, drying from 4 to 6 hours, when air-dried, or 200 deg. F. oven-wise.

For a double-purpose primer and ground color coat, a baking graining stain and two or three coats of baking varnish or clear lacquer can be applied. When varnish is applied as a clear coat, it may be baked at 275 deg. F. for about an hour. The varnish should be hard, flow easily, and be print-proof. Where air-drying methods are in force, varnish can also be used, allowing the work to dry 24 hours between coats, then letting the work stand two to three days, then rubbing and polishing.

When a clear coat lacquer is applied, two hours should be allowed for drying between coats, and overnight drying before rubbing.

For filing cabinets some shops employ an oil primer of neutral color, sprayed on lightly, thoroughly covering every portion, inside and out, then baking at 275 deg. F. for two hours. The primer coat being reasonably short in oil prepares for an easy sanding. This operation is favored as it is vital that each defect in the metal and spotweld mark must be puttied and a uniformly smooth surface be obtained prior to the next operation. Many finishers maintain that a separate priming coat is expedient albeit not absolutely necessary.

Overcoming "Lifting"

The putty employed is of pyroxylin base, but one drawback at times is that when the final coat of lacquer is applied, lifting of the grain occurs. In most instances this trouble is due to insufficient drying. Too much putty may be used, inadequately dried before applying the next coat. If more

drier is used in the graining color, this difficulty of lifting of the grain can also be overcome.

For filing cabinets, some shops use a quick air-drying graining stain, eliminating all difficulty of lifting or crawling. First, a coat of lacquer graining ground is overlaid. Drying speedily, it eliminates much of the dust hazard, assuring a perfect surface for graining. Then the air-drying graining stain in paste form, of the same consistency as the oil graining stains, is put on. This can be reduced with water and will dry in about a half hour. This material can be retarded with a special retarder. Or, the stain can be force-dried for ten minutes at an oven temperature of 150 deg. F., following up with one coat or two of clear lacquer.

Some grainers prefer an oil-base putty, baked on. No matter what materials or methods are used, it is always desirable that the metal surface be completely dry before applying a succeeding coat.

For graining, either water colors or oil colors can be used. Being in paste form, the graining stains or inks are reduced to the proper consistency for the particular work under hand. The stains are workable for a long time, but usually grainers prepare enough for immediate needs, especially where there is a variety or only a limited amount of graining.

Some plant managers prefer to allow more time for baking of the graining stains, particularly on the superior types of steel office furniture. Ordinarily the baking time for the graining stain is the same as for ground coats. Sometimes the work is baked for 3 hours at 250 deg. F., on the larger, expensive items. More and more shorter schedules, however, are being used, especially for the smaller units and where fast-drying methods and quantity output are in order. Generally, improved materials conduce toward faster finishing all along the production line.

Water Colors

Water colors for graining have the asset that the graining can be done more quickly and easily, and the water-soluble graining colors will not require oven baking. And the colors stand out markedly under clear lacquer or clear varnish.

For illustration, to simulate a true mahogany color and grain, following

the application of a suitable mahogany ground coat, specific materials can be Van Dyke brown, crimson lake, drop black and burnt sienna. A sponge or a cotton cloth can be used to execute the sought design, seeing to it that the sponge is amply filled with the predominating drop black color. A mottler is used to bring out the lines naturally. While the graining stain is still wet, the use of a badger blender will serve to execute the natural characteristics of real mahogany. When the initial graining colors are dry, the surface and over-grain can be gone over with the same graining color, then stippling the entire work and blending ever so gently, so that the stippling will not stand out too pronouncedly.

If oil colors are chosen for the mahogany grain finish, the paste stain is reduced to workable consistency with one part of linseed oil, three parts of turpentine and one part of japan drier to each part of paste. Some grainers use a greater portion of linseed oil and less turpentine, proportionally, some not even adding the drier, but the latter is advisable since it hastens the graining and lessens if not entirely eliminating the lifting of the grain. Individually the grainers reduce the graining stains to suit their own particular preferences and purposes and they all originate artistic characteristic effects.

Graining Technique

Occasionally the practice of wiping out the stain with a rag to bring out the natural growth of the wood, as followed by some grainers, tends to create an unrealistic and cloudy design when finished. It may almost simulate the natural wood, but not so well as when executing this growth with a brush and drop black.

Some grainers use a wet and dry brush, applying the stain liberally and brushing out with the dry brush. Drop black in oil is ordinarily preferred, but drop black in japan is also serviceable. The procedure, for example, is to mix three parts of turpentine and one part of drier in a small vessel, squeezing a small portion of black from the tube on a steel plate; the brush is dipped in the solution and worked with the black very much like any artist as the expert hand grainer professes to be. The proper graining brushes should be available to produce those delicately fine lines character-

istic of true mahogany.

It seems there are no two hand grainers using identical methods. It is much a matter of hand manipulation and some skilled artisans in this line achieve admirably superb effects with a peculiar set of methods and materials while another equally adept grainer applies an entirely different course, also turning out individualized superfine workmanship.

When hand graining filing cabinets to resemble American walnut, a stain can be prepared consisting of 2 parts of turpentine, 1 part boiled linseed oil and a few drops of japan drier. After this is mixed, add Van Dyke brown until the desired shade is obtained. This stain should be brushed on ever so lightly and evenly, so that the undercoat is still visible.

Applying the Stain

Then with sponge or cloth apply the graining colors. Have in readiness some turpentine, also a little of drop black and some burnt umber. Then a small over-grainer can be dipped lightly into this turpentine and black, by means of palette or similar equipment, and then the desired figures or crotch grain can be worked in. The remainder of the work can be performed with a 4-inch over-grainer, using a little Van Dyke brown or burnt umber, depending upon personal choice. The darker veins or lines can be worked in skilfully with the over-grainer dipped in a little drop black, then toning down with a mottler brush and blending out with a badger blender.

Various methods can be used to achieve the effect of pores. An over-grainer or stipple brush will prove aidful. Some grainers rely on a check roller for this purpose, mixing the graining color with naphtha, then manipulating the check roller, one with a brush attachment. Care should be observed so that the right pore effect will result, and not take up too much color at a time on the brush. Whenever the color runs too freely, this object is sometimes negated. The purpose should be not to get too much color on the check roller.

There is also a variety of graining done by roller, transfer or machine process. Some shops use rollers that already incorporate various figure imprints on the surfaces. However, most plants use etched transfer or graining plates in conjunction with a smooth

composition roller. For printing a precise reproduction of wood graining on steel, an etched plate may be a prepared panel of the actual wood, with the surface imitatively etched. In this instance the wood plates should be treated with a weak solution of sulphuric acid to etch the pores deep enough to ensure sharp, clear-cut impressions. An alkali solution or mild acid solution will serve in place.

Copper Plates

Etched copper plates usually give the best graining results. These plates are more expensive and some plants have only a limited number. A copper plate is made by developing a photograph of the true wood to be simulated in conjunction with the etching process. In this case the true graining and other natural characteristics in the wood are exactly reproduced in the negative and in turn transferred to the copper plate. A wood panel or plate, although embodying various natural features of the original, such as knots, burls, and light and dark sap streaks, cannot be treated with the stain deftly enough to heighten these elements in the reproduction.

By means of copper plates these finer, important details distinctly stand out in the completed grain work.

The graining ink or paste, thinned to proper working consistency, is applied to the etched face of the plate with a scraper, working well into the impressions, covering all the details, but wiping the stain clean from the high places, so that only the pores and low spots retain the stain. A smooth, soft composition roller is then carefully rolled over this inked plate. The aim should be to make one, steady, complete revolution, to absorb accurately the inked impression. On large, difficult work sometimes two operators, one at each end of the roller, perform this transferring.

The ink being imprinted on the smooth surface of the roller, the grainer now transfers the roller to the prepared steel surface to be grained, deftly rolling it over the ground color surface.

By means of various stencils, different designs or decorative effects can be superinduced by the same process, such as inlays or overlays when the management desires to imbue the product with distinctively individual features.

Whether air-dried or bake-finished, the filing cabinets are now given one or more clear finishes. These coatings can be either varnish or lacquer, depending on the character of work, and either air-dried or bake-finished. The plants striving for a high-quality article in all ways, the filing cabinets likely will now receive a final rub, wash and polish.

Quality Materials

For steel office furniture it is important that only high quality enamels and lacquers be used, as the product must naturally undergo severe handling and testing. Good steel office furniture is expected to last for a number of years, and hence sturdy, durable surfaces are desirable. Obtained there may be a better insight into the real possibilities of the correct, dependable finishes when the management consults with different manufacturers regarding their respective finishing materials, then following instructions where their products are used. Usually a representative will only too eagerly demonstrate finishing potentialities, and otherwise assist in bringing about efficient performance.

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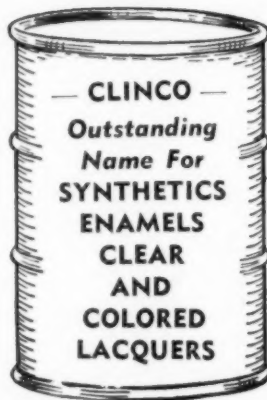
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Fire Protection for Finishing Processes

Carbon Dioxide Broadens Its Uses in the Metal Finishing Industry

By P. W. EBERHARDT

Walter Kidde & Co., Inc.
New York

Because of the large quantities of flammable liquids used in the preparing and coating of surfaces, most metal finishing plants are highly vulnerable to fire. And because these fires can often get out of control and either destroy a factory or at least seriously cripple production, much thought and research has gone into this problem of fire protection in recent years.

One of the most versatile and effective of the recently developed fire extinguishing techniques involves carbon dioxide, a gaseous extinguishing agent which has been adapted to fighting many types of industrial fires, particularly where flammable liquids are involved. Its effectiveness is largely due to the fact that, like fire, it is three-dimensional in action, and thus can penetrate into crevices and past

obstructions wherever fire may burn. Also, it can envelop and smother a liquid fire even though it may be running down the side of a tank or down a stairway or shaft—a problem difficult or impossible for liquid extinguishing agents.

Carbon dioxide fire-fighting came to American industry after an apprenticeship on the sea: First installations were on cargo boats where holds were flooded with clouds of carbon dioxide in event of fire, and on oil tankers, where curtains of gas were blown across hatch openings to separate flames from their fuel and to cut off the oxygen supply. Then, a few years later, telephone engineers introduced the gas extinguishing technique to American industry. They used it to fight switchboard fires, for these deli-

cate mechanisms are so allergic to moisture that they are covered with canvas jackets whenever a well-meaning fireman appears with a water hose. Today, portable carbon dioxide extinguishers, with special nozzles designed for the purpose, are standard equipment in almost every telephone exchange. After perfecting such portable units, fixed systems for the protection of concentrated flammable liquid hazards in industry were a natural development.

How Systems Work

To those who have never seen a carbon dioxide system actually discharge, a description is in order. For example, a spray-room or oven is a concentrated hazard on which a "total-flooding" system is generally used. "Total flooding" means that enough gas is stored in high-pressure cylinders to flood the entire room or space and provide an inert atmosphere from floor to ceiling. When the oxygen content of the air is cut from the normal 21% to 14% or 15%—at which point fire in solvents, varnishes, etc. cannot exist—all trace of fire is extinguished.

When fire breaks out, the rapid heat rise sets off an automatic release which instantly opens the cylinder valves. From its own stored pressure, the carbon dioxide rushes through discharge nozzles, instantly smothering all flames. By means of gas-operated pressure tips, doors and windows are quickly closed to retain the gas in the protected space. Other openings which cannot be closed mechanically are covered by "screening jets" of the gas. Within a few seconds the oxygen content of the entire room is below 14%—and the fire is out.

Releasing this great volume of gas, which expands 450 times as it leaves the nozzles, also deserves and explains

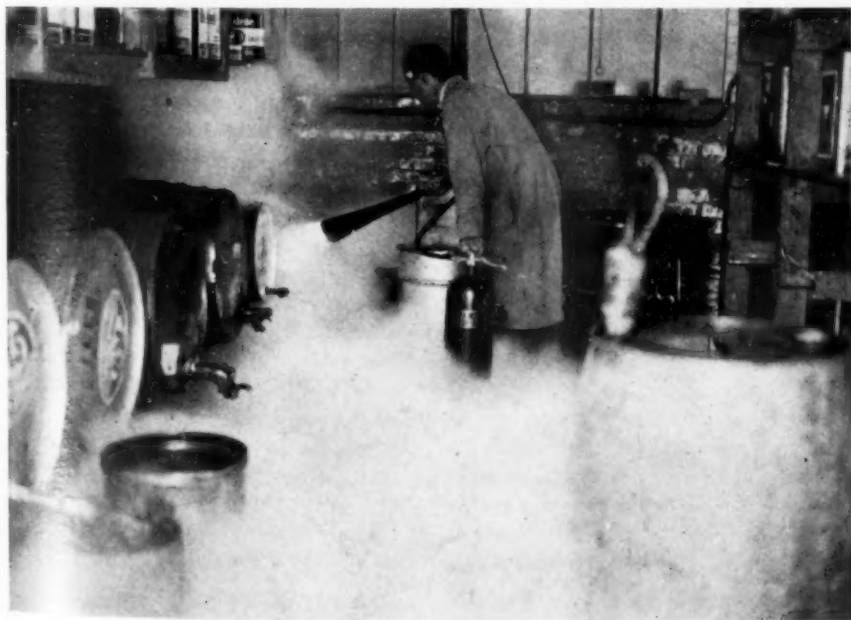


Fig. 1. Use of a portable carbon dioxide unit on a store-room fire shown in this photo. Employee blankets the burning surfaces with gas, which penetrates past and around obstructions. Similar units are used to protect spray booths.

ation, for it involves physical phenomena that prevented earlier adoption of carbon dioxide for fire-fighting. Because of this rapid expansion taking place in ordinary cylinders and valves, freezing resulted. Special valving arrangements and syphons had to be developed to permit complete discharge of the contents of a fifty, seventy-five or 100 pound or larger cylinder in a few seconds without danger of freezing.

Estimating Gas Needs

"Total flooding" arrangements similar to the above are used on any enclosed hazard involving flammable liquids or electrical equipment. As a guide in estimating gas requirements, the following recommendations can be used:

Up to 1,600 cu. ft. of space—	16 cu. ft. per pound of gas.
Up to 4,500 cu. ft. of space—	18 cu. ft. per pound of gas.
Up to 50,000 cu. ft. of space—	20 cu. ft. per pound of gas.
Over 50,000 cu. ft. of space—	22 cu. ft. per pound.

This table is based on liquid hazards with the approximate character of gasoline which includes many lacquers, solvents, etc. Where flammable liquids that will burn with a lower oxygen content are involved, corresponding increases in gas requirements are made.

Dip-tank Protection

One common hazard in metal finishing plants is the dip-tank and drain-board, and a somewhat different type of carbon dioxide system, called "lo-

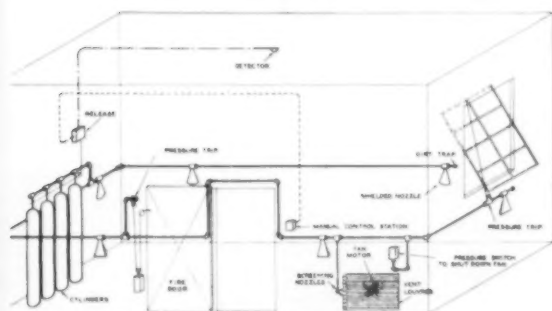
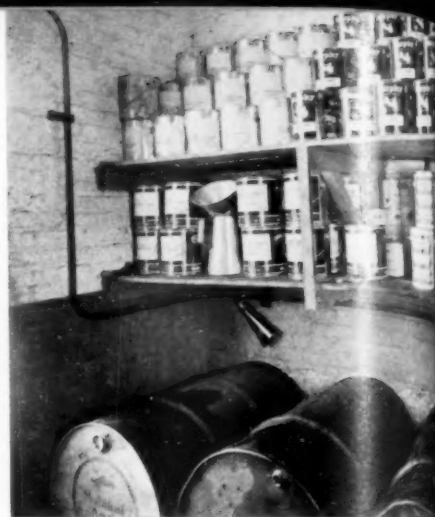


Fig. 2. Fixed "total flooding" carbon dioxide systems, used on concentrated hazards in enclosed spaces, are usually set up as shown in this diagram. At the first wave of abnormal heat from a fire, the gas is released automatically, and door and window trips operate simultaneously to retain the gas.

Fig. 3. A fixed system is used here to protect a finishing plant store-room, with automatic detection to assure instant operation day or night. Because fires in such spaces are extremely difficult to fight by hand, because of smoke and fumes and heat, such protection also safeguards lives.



cal application", is widely employed here. Foremost advantage of the method is the speed with which tank fires are smothered, and second is the fact that the gas and snow puts out the fire without contaminating the lacquer or enamel in any way or requiring any clean-up. The snow particles evaporate instantly, and the dipping operation can be resumed a few minutes after a fire. In this method of application, the discharge nozzles are usually directed toward the surface of the liquid, so that the gas quickly blankets the tank and drainboard and smothers the fire—despite obstructions formed by parts and conveyor hooks.

Similarly, ovens used in conjunction with dip-tanks can be protected by the same carbon dioxide supply, sometimes with directional valves to shunt the gas supply to either point. Tripping the release valves may be automatic, manual, or a combination of both. Most widely-used automatic control is the rate-of-temperature-rise type, consisting of a sealed metal container located over the hazard and connected by tubing to the release mechanism. When fires occur, the sudden abnormal heat rise expands the air in the container and trips the release. The automatic control system is vented so that slow or normal heat increases do not trip the valve mechanism.

Storeroom Fires

One recent trend in inert gas protection is its use to flood enclosed spaces where flammable materials are stored. These storage rooms where lacquers, enamels, thinners, etc. are kept provide a difficult extinguishing problem in event of fire, for the heat is usually intense, fumes are dangerous, the cans and drums offer obstructions to liquid extinguishing streams while the ever-present possibility of explosion makes men timid about fighting such fires. Carbon dioxide systems, however, automatically flood the room with gas without the need for human assistance

or watchfulness, and because of the three-dimensional action of the gas, it instantly penetrates into crevices and between cans to smother every trace of flame.

Similar smothering systems are widely used in transformer and circuit-breaker vaults where flowing and burning oil resulting from a failure in the equipment constitutes a serious hazard. While ramped sills, fire-proof partitions and other precautions are valuable in confining such fires, many plants provide carbon dioxide protection in the form of "total flooding" systems. The complete dryness of the gas is particularly valuable on electrical fires because windings and insulation are not damaged, and because it has a higher dielectric strength than air it does not ground energized equipment.

Portable Units

Portable carbon dioxide extinguishers employ the same basic type of steel cylinder as do the fixed systems, except that they are lighter in weight and have hand operated quick-opening and closing valves. The smallest size, a two pound, foot-long pistol grip model has a trigger-valve and nozzle that can be aimed and discharged like a gun, while the larger sizes, ranging up to 100 pounds capacity, have hoses and flared discharge nozzles. All of them can be carried or wheeled to the scene of the fire where their gas blanket can be directed to fight the trickiest running or pouring fire, or flames in a maze of wires or complicated apparatus. Hose-reel units, supplied by one, two or more fixed cylinders, are also used in rooms where fires might break out at any point, and on the motorized fire trucks frequently used in large plant properties. They provide a large reserve supply of gas ready for instant use.

SPRAY PAINTING SCHOOL

The DeVilbiss Company, manufacturer of spray painting equipment, has announced the schedule of its Training School for spray painting equipment users for the first six months of 1941.

This school, which is open to industrial painters, master painters, automobile refinishers and all others interested in learning the technique of spray painting and the use and care of spray painting equipment, will be held at the company's Toledo, Ohio, plant.

Dates for the start of each training period are: January 20, February 17, March 17, April 21, May 19 and June 23. Sessions will last for one week, each.

Early as possible enrollment in the school is advised. Size of classes is limited. Because of the facilities for study available only at these sessions, the school always has, in the past, been well attended.

Men attending the school are offered the advantage of special rates in Toledo hotels and boarding houses. These already have been arranged by the company.

Complete information about the DeVilbiss Training School may be obtained by writing The DeVilbiss Company, 300 Phillips Avenue, Toledo, Ohio.

Finishing Digest

Coating Composition

U. S. Patent No. 2,220,152. C. R. Hill. November 5, 1940. A protective coating composition comprising petroleum naphtha containing in solution 2 oz. of rubber, 2 oz. of paraffin wax and 3 lbs. of resin per gallon of naphtha.

Corrosion Resistant Composition

U. S. Patent No. 2,216,514. D. Isenberg, assignor to Surface-Proofing Products, Inc. October 1, 1940. A corrosion resistant composition containing the following ingredients in substantially the proportions given:

- 40 gal. of a synthetic varnish
- 5 gal. ethylene glycol monoethyl ether
- 0.5 gal. of pure gall obtained from fowl
- 2 gal. of high test alcohol
- 1 gal. cobalt liquid drier.

The fowl gall imparts stability against attack of the coating by the corrosive materials.

Protective Coating

U. S. Patent No. 2,216,376. R. A. Rimmel, assignor to M. B. Suydam Co. October 1, 1940. A protective coating is produced on articles such as pipes, wire, bars, strips, sheets, etc. which leave the mill in a heated state, by quenching while at a temp. of 200-600° F. approx. in a substantially neutral bath at room temp. and containing an aqueous emulsion, having an oil phase, in parts by weight of raw linseed oil or boiled linseed oil 65-85 parts, oleic acid 8-12 parts, methanolamine 1.8-4 parts, trisodium phosphate 3-6 parts, octyl alcohol 0.75-1 part. The temperature of the ar-

ticle is simultaneously reduced and the article is coated with the emulsion. The protective coating develops upon evaporation of the water phase of the emulsion.

Preventing Occupational Sickness

Preventing Occupational Sickness Caused by Solvents in Spray Lacquering. H. Bertram. Farb. Ztg. 45, 296 (1940). A review of preventive measures in avoiding occupational hazards.

Borderline Emulsions

Borderline Emulsions. H. Wagner. Farben Ztg. 45, 293-4, 307-8, 325-6, 343-4 (1940). Emulsified paints of the water-in-oil types can be divided into three classes with regard to their behavior in storage: Type A which is characterized by instability, Type B which is characterized by borderline stability, Type C which is completely stable. Type C is usually made with larger quantities of emulsifiers, such as soaps, than type

B, whose preparation usually requires the simultaneous use of such emulsion assistants as phenol. There is a fundamental difference in the role played by water in each of these types, particularly during the drying period of the paint.

Lacquer Composition

Composition of Nitrocellulose Lacquers and their Water Resistance. B. F. Tyurin and Ya. P. Levit. Byull. Obmena. Opyt. Dakokrasochnoi. Prom. 3, 34-38 (1939). The writers point out that one of the basic causes of corrosion and failure of paint films is their water permeability due to capillarity caused by evaporation of the solvent media. The writers attempt to establish an equation which will give the water permeability of a given paint film. The equation: $K = VD/AT$, where K is the constant of permeation, V is the grams of moisture that go through the film in T hours, D is the film thickness and A is its area.

EGYPTIAN high-bake N.F.R.

A tough, mar-proof, chemically resistant synthetic finish for all types of metal products . . . Extremely durable. Increases resistance to abrasion and other forms of wear



WIDE RANGE OF BAKING TEMPERATURES

SPECIAL UNDER COATS FOR ROUGH CASTINGS WHICH AIR DRY FOR SANDING YET MAY BE BAKED AS A COMPOSITE FINISH AFTER APPLICATION OF EGYPTIAN high-bake N. F. R.

ONE COAT DIRECTLY ON SMOOTH METALS. NO PRIMING COAT NECESSARY.

Ask for further information

THE EGYPTIAN LACQUER MANUFACTURING CO.
ROCKEFELLER CENTER
NEW YORK



EGYPTIAN FINISHES

• In addition to High-Bake N. F. R. we also make a complete line of clear and pigmented lacquers for standard and individual requirements. These are furnished for spray dip or brush application . . . Air-dry and bake.

Ask for details



EGYPTIAN Superior FINISHES

NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

Quick Drying Enamels

A new line of synthetic enamels that air-dry so hard in 24 hours that they will not "paper print", is announced by Maas & Waldstein Co., makers of industrial finishes, Newark, N. J.

These new finishes, which are known as "Coprene enamels", have a chlorinated-rubber base. They air-dry dust-free in a very few minutes and become very hard over night under normal application conditions. The hardening is not merely a surface change, as is the case with most air-drying synthetic enamels, but extends throughout the entire coating, thus making it resistant to handling, wrapping, etc. Similar hardening can be obtained by force-drying for 1 hour at 200° F.

Coprene enamels are supplied in clear, black, white, and colors, and also in silver, copper, and other metallic lustres. According to the manufacturer, they have good adhesion, good resistance to outdoor weather and household chemicals, and retain their gloss, flexibility and color well. They are suitable for use on all kinds of metal products, and also on wood, either over a surfacer to produce a smooth finish or directly on the grain.

Moisture Detectors

Colloid Equipment Co., Inc., 50 Church St., New York City, have announced the development of moisture detectors to determine whether the moisture content of surfaces to be finished, is sufficiently low to allow finishing.

The use of the moisture gauges is said to eliminate subsequent peeling and blistering of the applied finish because of moisture being trapped in the wall. The determination is made instantly by pressing a needle electrode into the material to be tested. A button is pressed or a knob turned and a dial indicates the degree of moisture present.

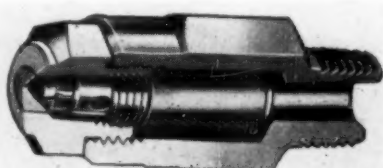


Using moisture detector to determine moisture content of wall before painting.

The instruments are stated to be rugged, compact and portable. They are recommended for testing such surfaces as plaster, brick, concrete and wood prior to organic finishing.

Nozzle with Square Spray

Spraying Systems Company, 4021 W. Lake St., Chicago, Ill., have placed on the market, a spray nozzle called "Fulljet", which is available in brass, though other materials can be specified.



Nozzle with square spray.

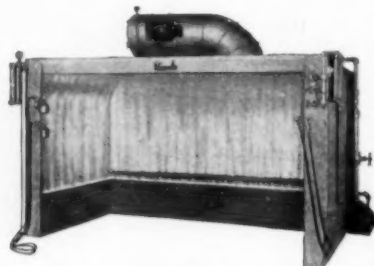
The pipe connection is $\frac{1}{2}$ " male and capacity is 2.5 or 2.9 G.P.M. at 10 pounds pressure. The nozzle produces a full-cone square spray with uniform distribution. This same nozzle can be furnished with round spray pattern. The manufacturers report that it is of sturdy construction and has large passages making it almost clog proof.

This nozzle can be used for various industrial and chemical processes, gas washers—evaporative condensers.

Water Wash Finishing Booths

Paasche Airbrush Co., 1909 Diversey Parkway, Chicago, Ill., have announced their latest type of water-wash air finishing booths, which may be had with water-wash for back, sides and at the bottom. The water-wash below shelf is a particularly desirable feature when shelf water-wash booths are to be used.

The booth includes panels, a wash chamber, settling pan, eliminator plates, non-clogging nozzles, removable strainer, float valve and the flow of water of 4 gallons per minute, per foot of booth width, providing



Water-wash finishing booth.

a cleaning and washing operation that is 97% efficient.

These booths are claimed to reduce fire hazard; to effectively wash away all overspray; and to prevent accumulating solids on rear and side walls, ventilating pan and exhaust piping. The booths may be had in all types and sizes.

Non-Patented Lacquers

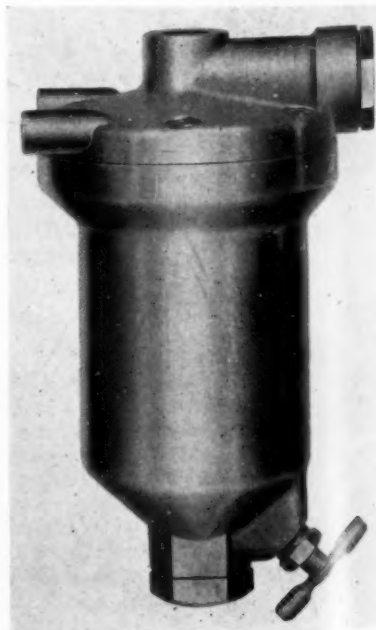
C. W. Haynes Laboratories, Inc., Springfield, Mass., have announced the development of non-patented lacquers which they are selling in black with high gloss, semi-gloss or flat finish.

The lacquers are stated to be of equal quality to the patented lacquers with qualities such as coverage, flexibility, adhesion, moisture resistance and aging; and in addition are stated to cost considerably less.

Automatic Water Drain

The DeVilbiss Co., Toledo, Ohio, have announced a new automatic water drain for use in compressed air lines. The drain is stated to be simple in construction and available with 4 fitting assemblies. It is known as Type HOD.

The drain is said to automatically remove moisture from the air line or air receiver preventing water from being carried into the tool being used, thereby preventing rust.



Automatic water drain.

ing and ensuring a supply of air free of moisture.

The fan is operated automatically by a slight fluctuation of the main line air pressure, and a variation of as little as five pounds is sufficient for its operation. A manual drain is provided for use in periods when the main air line is not in use.

Fan for Spray Booths

A new paint spray booth fan with guaranteed performance ratings has been placed on the market by the De Bothezat Ventilating Equipment Div., American Machine & Metals, Inc., E. Moline, Ill.

This fan is said to assure required protection against the hazards of spray painting under all operating conditions. It is stated to be built to underwriters' specifications, to be corrosion-resisting and non-sparking.

The motor is mounted outside the fan housing on an adjustable base, and power is transmitted by "V" belts through a vapor-proof drive chamber. The fan wheels are of die-formed aluminum and blades are easily removable for cleaning.

Manufacturers' Literature

Fans for Spray Booths. Fans for paint spray booths are described in a recently issued 8-page bulletin of the De Bothezat Ventilating Equipment Div., American Machine & Metals, Inc., E. Moline, Ill. The fans are stated to be non-corrosive and non-sparking and built to underwriter's specifications.

Fluorescent Lighting. Catalog No. 37 of the Edwin F. Guth Co., 2615 Washington St., St. Louis, Mo., is a recently issued publication giving helpful technical data and suggestions for lighting problems, using "Alzak" reflectors.

Publication on Finishing. Sherwin-Williams Co., Cleveland, Ohio, have issued Vol. I, No. 1 of a magazine to be published every other month. The publications will cover developments in the finishing field and will tell of the company's contributions to industrial finishing technique. Copies can be secured by making inquiry under company letter-head.

POSITION WANTED

Production Finishing Supervisor

Has technical study and experience in finish control, practical material testing, spray motion technique, and time and cost study.

Experienced sprayer of finishing materials—wrinkles, paints, lacquers etc. Age 28. Excellent references. Desires position as Asst. Finishing Foreman or Demonstrator of Materials or equipment. Will travel.

Sheet Metal Equipment. The Industrial Sheet Metal Works, 628 E. Forest Ave., Detroit, Mich., has just published an attractive spiral-bound catalog describing and illustrating the various products the company manufactures, such as spray booths, drying ovens, and parts washers. The company not only manufactures these items, but also engineers the complete installation of them and furnishes all the other related equipment, such as heaters, fans, controls, conveyors, etc. This service is also described in the catalog.

Spray Booth Cleaners. Wayne Chemical Products Co., Copeland & M.C.R.R., Detroit, Mich., have issued a 4-page folder describing the company's materials for cleaning paint spray booths. The materials are stated to permit easy removal of inflammable materials and to eliminate the building up of thick layers of organic finishes on the interior of spray booths.

Synthetic Organic Chemicals. Carbide & Carbon Chemicals Corp., 30 E. 42nd St.,

New York City, have issued an attractive comprehensive reference book entitled, "Synthetic Organic Chemicals" containing data on the properties and uses of 142 industrial organic chemicals manufactured by the corporation. The book is a completely revised and enlarged tenth edition.

Business Items

The American-Marietta Co., has started construction at its Kankakee, Ill., plant of two new buildings to handle the rapidly increasing demand for the company's products. The buildings are part of a \$200,000 modernization and expansion program at Kankakee that was begun about a year ago and is designed to carry over a period of 18 months. The figure includes buildings, equipment and improvements.

One building is to house a new varnish and synthetic resin laboratory provided with modern research and testing apparatus.



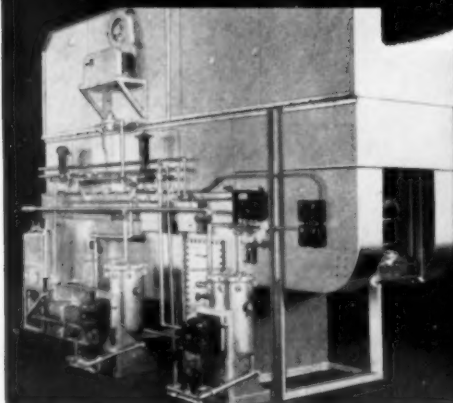
S-M-O-O-T-H...but TOUGH!

After months of research and testing, the Stanley Chemical Company is proud to announce a new Aluminum Baking Synthetic . . . No. 66H-1307. It's a new coating for metals, so s-m-o-o-t-h in appearance, that it looks like dull chromium plate; so TOUGH that after long exposure to wear and weather, it still retains its original color and brilliance. Although developed as a spray finish, Stanley 66H-1307 Aluminum Synthetic is extremely well suited to dip application, with complete freedom from streaks, runs, and drips. (Also available for Air Drying . . . No. 66H-1515). Order a five gallon testing sample TODAY. It will be billed at the drum price. Address Department "A".

THE STANLEY CHEMICAL CO.
EAST BERLIN CONNECTICUT
Lacquers · Enamels · Synthetics · Japans
A SUBSIDIARY OF THE STANLEY WORKS, NEW BRITAIN, CONN.

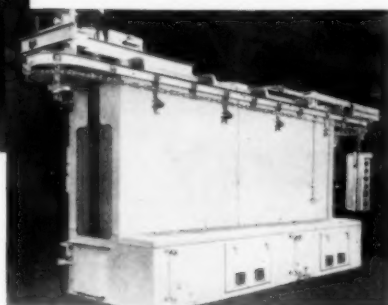
To Meet Your METAL CLEANING NEEDS for . . .

1941



A Vapor-Spray-Vapor Degreaser in which a conveyor has been incorporated. Used for cleaning aircraft engine parts.

A through-type washer with monorail conveyor designed for the cleaning of aircraft engines. In this washer emulsion cleaners are used.



Increased production . . . new types of production necessitated by defense orders . . . will call for "speed-up" and change in your metal cleaning departments. The equipment you will require must be engineered to handle your work quickly and economically. The materials you will use must be of proven quality. These are essential to an uninterrupted flow of work.

The selection of Detrex Degreasers or Detrex machines for Alkali, Spirits and Emulsion Cleaning . . . the use of stabilized safety solvents Perm-A-Clor and Triad or Triad alkali

compounds, strippers and emulsion cleaners especially suited to various cleaning jobs . . . will meet next year's requirements for many of the country's leading manufacturers. You, too, will find Detrex the exact answer to your 1941 metal cleaning problems.

Write for descriptive literature or free engineering consultation.



SOLVENT DEGREASING and ALKALI CLEANING DETROIT REX PRODUCTS COMPANY

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Save Time and Money

BY USING QUICK, SAFE ENTHONE BAKED ENAMEL STRIPPERS

Enthone baked enamel strippers cut actual stripping time from HOURS to MINUTES . . . quickly and safely removing baked enamels of the urea-formaldehyde, resyl, glyptal, glycerolphthalic anhydride and bakelite types . . . as well as many other long-oil types of japans and air-dry enamels. Non-caustic, will not etch or attack any metal. Strip rapidly—rinse freely!

Write TODAY for FREE SAMPLE and valuable advice for cutting your enamel stripping costs.

The **ENTHONE Co.**

NEW HAVEN, CONN.

Chemical Products



The company will conduct considerably more research on domestic oils because of the curtailed import of such essential oils as china wood and perilla oils.

Hilo Varnish Corp., 42-60 Stewart Ave., Brooklyn, N. Y., have announced that *Robert E. Templeton*, has joined the staff as sales representative. Mr. Templeton will call on the industrial trade in New Jersey and Eastern Pennsylvania. He was formerly employed by *Sherwin-Williams Company* in the New York area and has considerable laboratory experience, as well as holding a position of field service man and industrial salesman.

Leonard S. Parker, who for a number of years has been superintendent of production for *Skilsaw, Inc.*, Chicago, has been named Vice-President in Charge of Operations, according to announcement just released. Mr. Parker has been associated with the *Skilsaw* organization since 1931, so he brings to his new responsibilities an intimate knowledge of the portable electric tool field.

Harry G. Schoene, former salesman for the *Sherwin-Williams Company*, has been appointed sales manager of the *H. Forsberg Company* of Cleveland, a manufacturer of industrial production finishes.

Schoene was connected with the *Sherwin-Williams Company* for 20 years, selling their line of production finishes to manufacturers in the Ohio, Michigan, West Virginia and St. Louis territories. He is experienced in the raw-material, laboratory and service divisions of the paint industry, and has handled a large volume of fleet, bus and body business.

Finished Products Exhibit

Maas and Waldstein Co., 438 Riverside Ave., Newark, N. J., are showing an exhibit of many types of products finished with the latest developments in clear lacquers, lacquer enamels, synthetic air drying and baking enamels. The showing is from Jan. 6 to Jan. 30 inclusive from 9:30 A.M. to 5:00 P.M. daily. Anyone interested in these new finishes is welcome to attend.

Modern Organic Finishing of Maytag Washing Machines

(Concluded from page 53)

control of the finish more nearly perfect, is the new paint storage and mixing room. In this room will be found an automatic heater to maintain proper temperatures, even in the coldest weather. New circulating tanks and pumps were installed, along with master liquid pressure regulators and filters, Master air regulators, and individual regulators on liquid and air for each operator. The system will handle prime coats, and final coats of one or more colors. With the constant temperature of the room and its contents it has been entirely possible, by the use of viscosities, to control the spraying consistency of the finish at all times.